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TABLE OF CONTENTS ON PAGE 2

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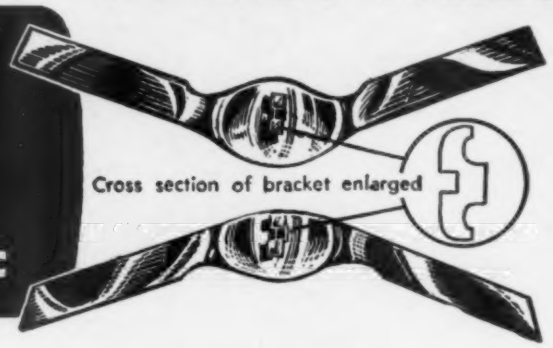

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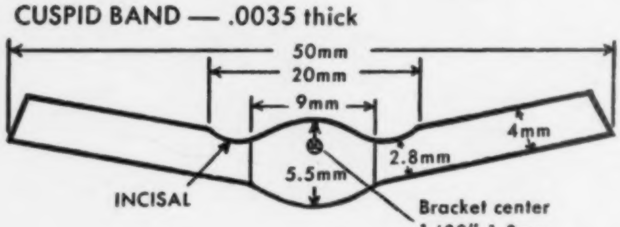

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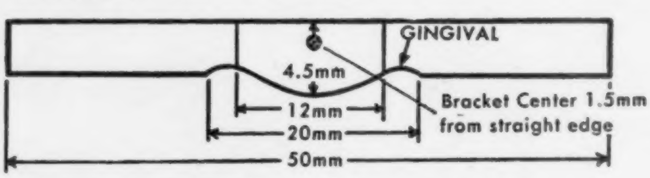

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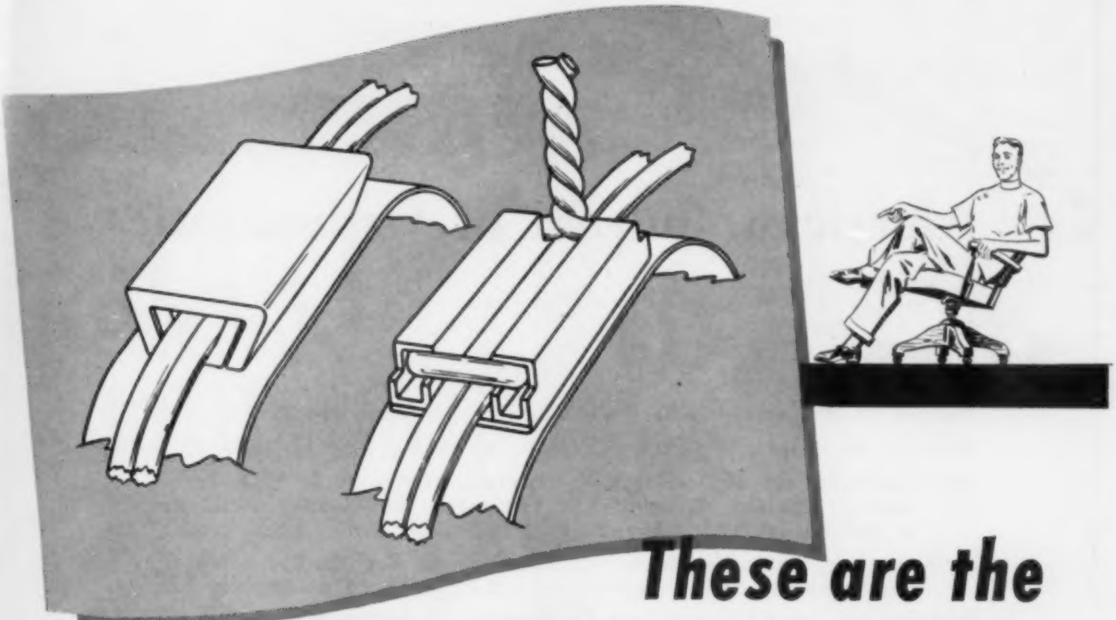

CONTENTS FOR OCTOBER, 1955

American Journal of Orthodontics

Original Articles

Editorial

Reports

Orthodontic Abstracts and Reviews

News and Notes

Officers of Orthodontic Societies

(Editorial and Business Communications on inside back cover)

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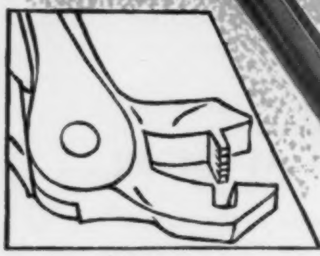

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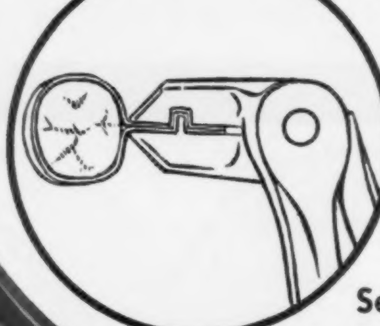

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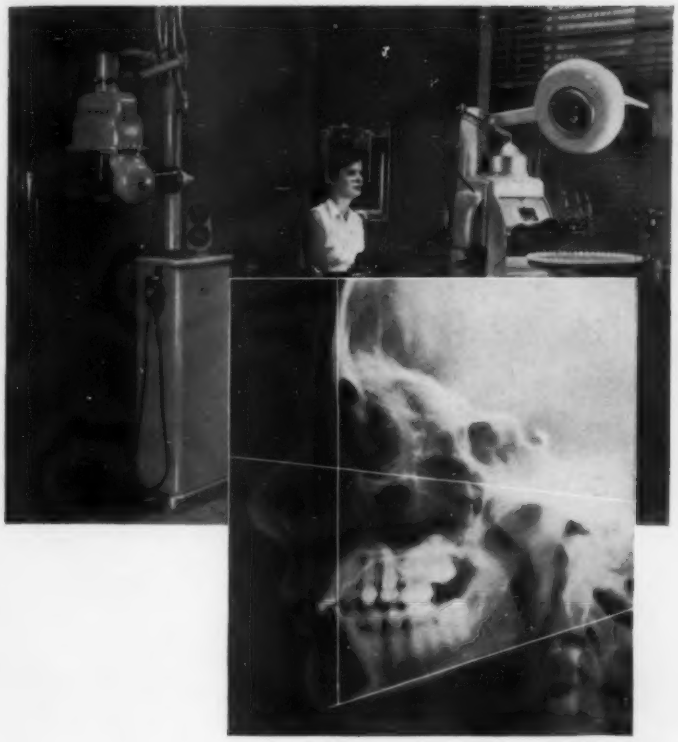


American Journal
of
ORTHODONTICS

VOL. 41 | OCTOBER, 1955 | NO. 10

Original Articles

ADDRESS OF WELCOME

WILLARD C. FLEMING,* SAN FRANCISCO, CALIF.

ONE of the occupational hazards of a dean is that eternally he is called upon to make speeches. These speech requests range from learned discussions on the etiology of cancer to simple announcements to students. My speech this morning comes somewhere between these two, and is classified as an address of welcome. Of course, this immediately poses another problem, because after you have said, "Hello," there is little else to say, and if you try to expand this topic you find yourself getting into other fields, such as ethics and jurisprudence or the advantages of the edgewise over the ribbon arch.

I have chosen a subject that consists of equal parts of history and crystal gazing. I am going to speak briefly on the changes in the dental curriculum that have been brought about by the changes in the world about us. In other words, over the past 150 years our profession has been a dynamic one, characterized by continually changing objectives which added to and increased the scope of our responsibilities. Dental education and the dental curriculum have also changed to meet these changing objectives and responsibilities. Perhaps a study of the past and the present will give us the courage to project into the future.

One of the first objectives we had was the relief of pain. There was no educational requirement to meet before one could attempt to accomplish this. Anyone with forceps or a pair of pliers and a strong right arm qualified—even the village blacksmith and the shoe cobbler.

The second objective was the restoration of teeth and parts of teeth. At this stage, the apprenticeship method of education was enough. The young man simply apprenticed himself to the older man, learned the tricks of the

Read before the annual meeting of the American Association of Orthodontists, San Francisco, California, May 9, 1955.

*Dean of the College of Dentistry, University of California, San Francisco, California.

trade, and eventually went forth to practice. Early orthodontic education began in this fashion. Surely it was a trade, with "trade secrets" jealously guarded, with teachers and apprentices formed together in little banks and cliques, where the defense of the technique and the personal prestige of the teacher were more important than the welfare of the patient.

Next, and this was not very long ago, came the knowledge of the relation between teeth and infection, the beginning knowledge of growth patterns and the relation of environment to growth and development. Here, again, the educational requirements changed, and we developed the four-year professional course at the college level. It became necessary to add the preclinical sciences, such as anatomy, pathology, bacteriology, physiology, and so forth. The unstandardized and inefficient apprenticeship method went into the discard.

We then entered the fourth period, and this is the period in which I think most of us are practicing. I feel that I am. This can be called the "Control Period." We have progressed beyond the simple treatment stage to a point where, with our increased knowledge of cause and, in the case of orthodontists, our knowledge of growth and development, we can control disease and guide growth, but are still unable to prevent disease or malocclusion.

It is in this control era that we "came of age" as a profession. We became an integral and important part of the total health program of the nation, and as we accepted new and greater responsibilities we had to assume a degree of leadership that had not been ours in the past. It was during this period that we developed the preprofessional college years as a prerequisite for the study of dentistry. It was, and is, evident that we must have dentists of a high caliber, with a broad background and understanding of social and economic problems—those problems that dentistry faces in the world today.

Obviously, the next step is into the field of prevention, and obviously research in dental disease and in growth and development will be the basic factor in this move. Graduate work in dentistry, with its emphasis on basic problems and research, will gradually grow. Postgraduate work, always of interest to the orthodontist as a means of preparation for his specialty practice, will gradually grow away from the undergraduate emphasis on techniques and will emphasize more and more the application of basic sciences to clinical practice. Professional dental teachers will grow in number and stature. The old groups of dentists held together by adherence to special techniques and articulators that grew out of the old apprenticeship days will disappear. In their place we will have groups of young men in large educational and research institutions, studying and developing in an atmosphere characterized by a free flow of words and ideas.

There is dentistry's story as I see it. I am grateful, as are you, for what our predecessors have done for us. We can never repay them for what they have done, nor would they expect it. All we can do is prepare, as they did, for the future. And so I welcome you to San Francisco to continue the progress that began so long ago.

RESPONSE TO ADDRESS OF WELCOME

PHILIP E. ADAMS,* BOSTON, MASS.

IT AFFORDS me great pleasure to have been awarded the privilege of responding, on behalf of the Association, to Dean Fleming's gracious address of welcome and of rendering the official thanks of the membership of the Association for the wonderful meeting and the cordial reception planned for us here in San Francisco.

When I noted in the program that I was to respond to the address of welcome, I observed that between the hours of 9:30 and 10:00 there were scheduled an invocation, an address of welcome, and a response, and I felt myself much in the position of the wife of the public official who had been selected to christen a ship. While she stood tightly grasping the magnum of champagne and waiting for the signal, she turned nervously to one of the shipyard officials and said, "How hard do I have to hit it to knock it into the water?"

Now I do not want to overdo this response, but I would be remiss, indeed, if I did not express, on behalf of those of us who have had the privilege of meeting here before, our very great appreciation for the opportunity of being here again and, for those who are making their first visit, their thanks for the unique and rewarding experience of meeting in this most interesting convention city, fabulous San Francisco.

To the local group I extend the sincere thanks of our members and their ladies for the splendid program of entertainment and hospitality arranged for us.

We are grateful to the Program Committee for the wonderful array of essays, clinics, and demonstrations, covering all phases of orthodontic practice, which they have assembled for us. It is commendable that each year we should all be stimulated by such programs to improve our orthodontic service and to be imbued by an almost divine discontent with our previous efforts.

And now, if I may be permitted to do so, I would like to give a very personal reason why I am thrilled to be here at this meeting, under these circumstances, in your wonderful city. Nearly six years ago it was my privilege and very great honor to assume the presidency of the American Dental Association in this very room. Thank you very much!

*President-Elect of the American Association of Orthodontists.

INTRODUCTION OF THE 1955 PRIZE ESSAY CONTEST WINNER BY DR. J. A. SALZMANN, CHAIRMAN, COMMITTEE ON RESEARCH, AMERICAN ASSOCIATION OF ORTHODONTISTS MONDAY, MAY 9, 1955

IT IS my pleasure and privilege, as chairman of the Committee on Research of the American Association of Orthodontics, to introduce the winner of the Prize Essay Contest, sponsored by the Association for the year 1955.

The winner is Dr. Viken Sassouni, a native of Lebanon.

Dr. Viken Sassouni was graduated in 1951 from École D'Odonto-Stomatologie et de Chirurgie Dentaire de Paris (Université de Paris, France). He received a certificate in orthodontics in January, 1955, from the Department of Orthodontics, University of Pennsylvania. At present he is an instructor in orthodontics and cephalometrics at the Philadelphia Center for Research in Child Growth in Philadelphia.

The title of his essay is "A Roentgenographic Cephalometric Functional Analysis of Cephalo-Facio-Dental Relationships Based on the Study of Concepts of Architectural Structure."

When Dr. Sassouni was notified that he was the winner of the Prize Essay Contest, he expressed his amazement to Professor Krogman, with whom he is associated, that our Association had seen fit to bestow this honor upon him, although he is not a native or even a citizen of this country.

May I take this opportunity to assure Dr. Sassouni that the American Association of Orthodontists, in keeping with the ideals of the United States of America, is interested not in his nationality or other personal prerogatives, but in his contribution to the progress of the art and science of orthodontics.

A ROENTGENOGRAPHIC CEPHALOMETRIC ANALYSIS OF CEPHALO-FACIO-DENTAL RELATIONSHIPS

VIKEN SASSOUNI, D.F.M.P., D.D.S., PHILADELPHIA, PA.

INTRODUCTION

Appraisal of Previous Cephalometric Roentgenographic Studies.—The introduction in 1931, of the Broadbent-Bolton cephalometer has opened a new field of investigation and understanding in the study of the head, face, and dentition.

Studies have been made to calculate facial dimensions and growth, and to establish the bounds of the normal range of variation.

For such a purpose, many points, lines, and angles have been chosen, as Na, S, Po, FH, Bo; generally this choice has been determined by fairly easy to locate points (as Na), to make possible the superimposing of tracings on a serial basis (as point R or line N-S), or to have a universal reference plane (as the FH) allowing comparison between different researchers. These planes and lines, however, do not necessarily reflect the bony planes of the face or its basic architecture.

The Skull, Battleground of Forces.—The architecture of the skull is the result of many forces, such as genetic forces in either racial or family line patterns, growth forces, muscular forces at rest (relatively static), functional muscle forces (dynamic), and environmental forces (health, diet, etc.), on the adaptable bony substance.

At each period of life the skull is the end result of the interaction of these forces.

Statement of the Problem.—How can we study the architecture or structural organization of the skull? How can we analyze it? What is the significance of such architecture for diagnosis and treatment? Are disturbances or disproportions in facial architecture possible etiological factors in orthodontics, prosthetics, oral surgery, and periodontics?

Material.—This study is based on tracings of 100 lateral head x-ray films taken with the Broadbent-Bolton roentgenographic cephalometer. In the sample there are fifty-one girls and forty-nine boys. They are white children, prin-

Awarded first prize in the 1955 annual Prize Essay Contest of the American Association of Orthodontists.

This is the expansion of a research problem undertaken in partial fulfillment of the requirements for the Certificate in Orthodontics, Graduate School of Medicine, University of Pennsylvania, December, 1954.

The collection of the data upon which this study is based was financed in part by United States Public Health Service Grants D-87 to D-87(C4).

cipally of Mediterranean racial origin. The chronological age ranges from 7 years to 15 years. All the x-ray films are from the files of the Philadelphia Center for Research in Child Growth.

TABLE I. SAMPLE OF 100 CASES ACCORDING TO DENTAL AGE, SEX, AND OCCLUSION

HELLMAN DENTAL AGE	SEX	OCCLUSION (ANGLE)				TOTALS	
		NORMAL	CLASS I	CLASS II	CLASS III		
III A	M	2	3	2	0	7	10
	F	0	1	1	1	3	
III B	M	5	4	3	2	14	31
	F	6	2	6	3	17	
III C	M	2	0	2	0	4	12
	F	4	2	1	1	8	
IV A	M	15	7	0	2	24	47
	F	16	1	5	1	23	
Total		50	20	20	10		100

Terminology.—

Planes (see Fig. 1):

1. *Mandibular Base Plane, OG.*—A plane tangent to the inferior border of the mandible.
2. *Occlusal Plane, OP.*—A plane going through the mesial cusps of the permanent first upper and lower molars and incisal edges of the upper and lower central incisors.
3. *Palatal Plane, ON.*—A plane perpendicular to the midsagittal plane, going through the anterior and posterior nasal spines (ANS-PNS).
4. *Anterior Cranial Base.*—Structurally, the floor of the anterior cerebral fossa. In the lateral x-ray there are two contours: the upper is the roofing of the orbit, including the lesser wing of the sphenoid, and the lower is posteriorly the spheno-ethmoid area and anteriorly the cribriform plate.
5. *Anterior Cranial Base Plane or Basal Plane, OS′.*—A plane parallel to the axis of the upper contour of the anterior cranial base and tangent to the inferior border of sella turcica.
6. *Ramal Plane, RX′.*—A plane tangent to the posterior border of the ascending ramus.

Arcs:

Anterior Arc.—The arc of a circle, between anterior cranial base plane and mandibular plane, with O as center and O-ANS as radius.

Posterior Arc.—The arc of a circle, between anterior cranial base plane and mandibular base plane, with O as center and OS^p as radius. (S^p is the most posterior point on the rear margin of sella turcica.)

Axes:

1. MM′M″.—Axis of $\underline{6}$.
2. II′I″.—Axis of $\underline{1}$.
3. ii′.—Axis of $\overline{1}$.
4. mm′.—Axis of $\overline{6}$.

FACIAL STUDY

The aim of this study is to try to find some acceptably constant relationships in the architecture of the head and to use them for diagnostic and treatment purposes in orthodontics.

Analysis.—We shall examine, in sequence, the mandible, the palate, and the anterior cranial base.

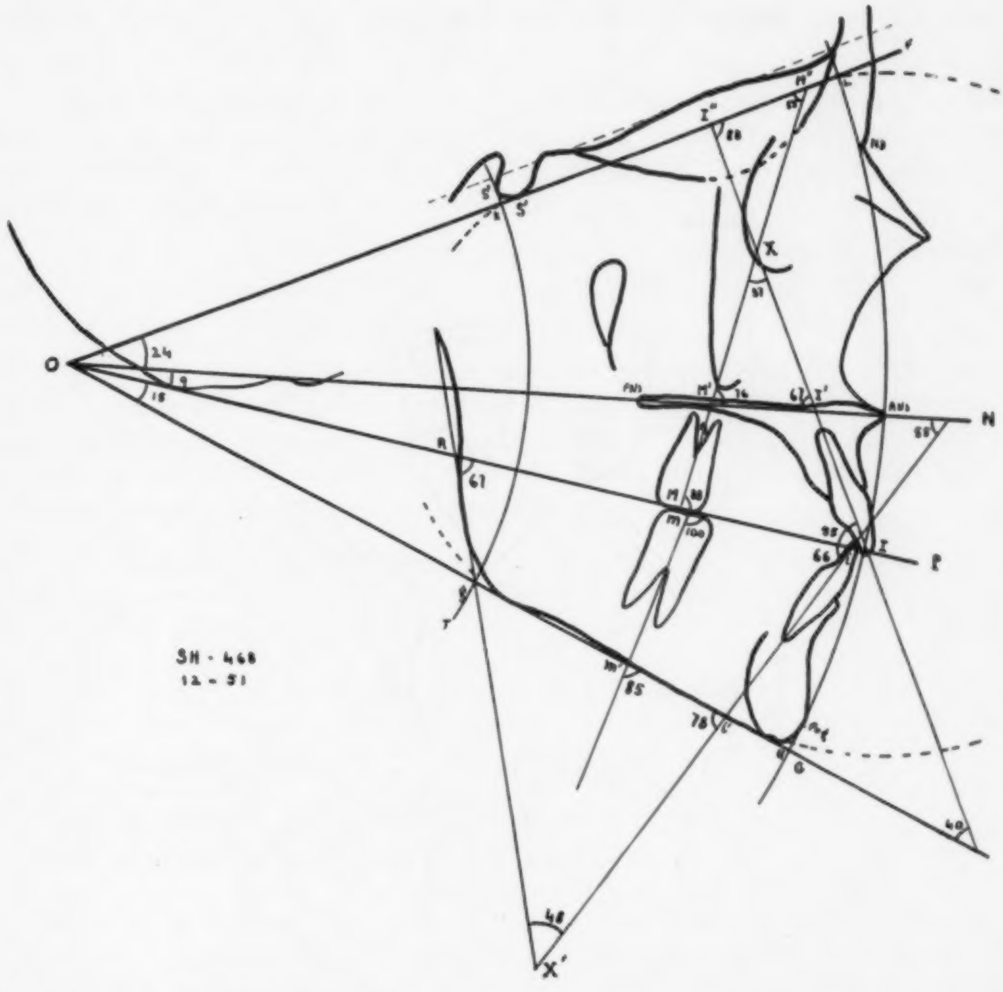


Fig. 1.—A well-proportioned face.

Planes: *OKS'I"M"LF* or *OS'*, Anterior cranial base plane; *O-PNS-ANS-N* or *ON*, palatal plane; *ORMmiIp* or *OP*, occlusal plane; *OgTm'i'UG* or *OG*, mandibular base plane; *RgX'*, ramal plane.

Arcs: *L-ANS-U*, Anterior arc; *S^pKT*, posterior arc.

Axes: *MM'M"*, Axis of $\underline{6}$; *II'I"*, axis of $\underline{1}$; *mm'*, axis of $\overline{6}$; *ii'*, axis of $\overline{1}$.

The mandible, as seen in lateral x-ray films, shows three main types: (1) curved, where it seems that the upward traction forces at the gonion and the downward pulling forces at the menton are in equilibrium (Fig. 2); (2) oblique, where upward traction and downward pulling forces seem to be so strong that

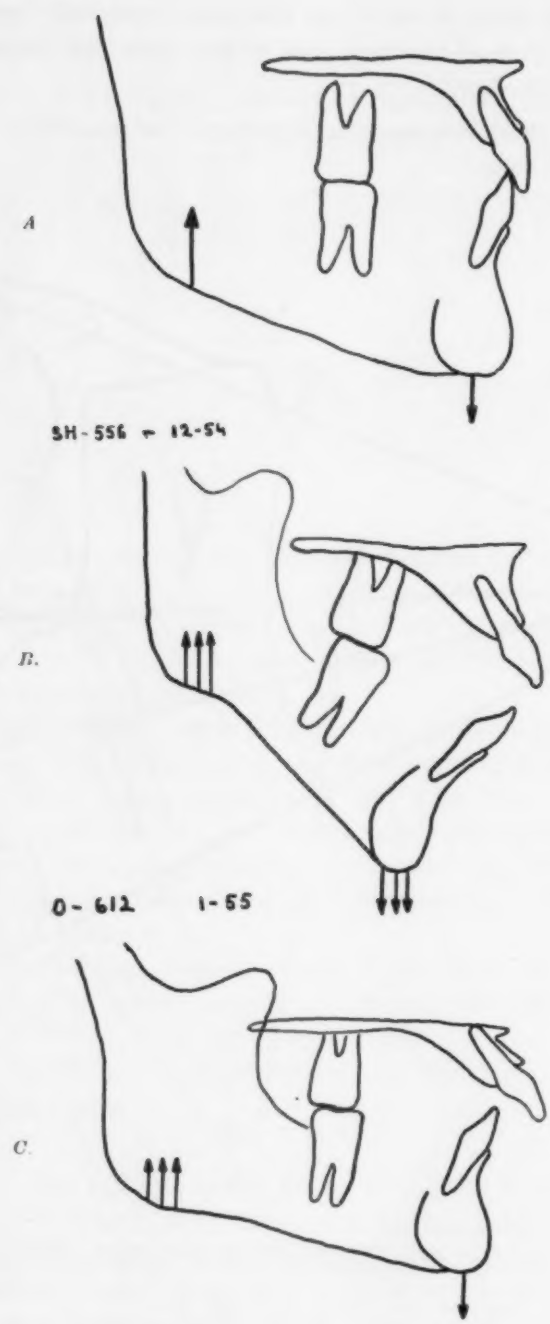


Fig 2.—Different types of mandible. *A*, Curved; *B*, oblique; *C*, horizontal.

we have a notch just anterior to the gonial insertion of the masseter (Fig. 2); and (3) horizontal, where the upward traction forces at the gonion seem to be greater than the downward pulling forces at the menton (Fig. 2).

The palate, as seen in lateral x-ray films, presents three types: (1) horizontal (Fig. 3, *A*), when the line connecting ANS and PNS passes through the bony structure of the palate; (2) convex (Fig. 3, *B*), when the line connecting ANS and PNS passes above the bony structure of the palate; and (3) concave (Fig. 3, *C*), when the line connecting ANS and PNS passes below the bony structure of the palate.

Relationship between the palate and the mandible: Generally with a curved mandible we find a horizontal palate (Figs. 2, *A*, 6, and 8); with an oblique mandible we find a convex palate (Figs. 2, *B* and 18); and with a horizontal mandible we find a concave palate (Figs. 2, *C* and 19).

The key ridge, as seen in lateral x-ray films, presents two shapes: (1) vertical and straight, or l-like (Fig. 3, *A*), and (2) double-curved, like a reverse 3 or like a sigma (Σ) (Fig. 3, *B* and *C*).

Correlation between the key ridge and the palate (Table II): When the palate is concave or convex, the key ridge is Σ-like (Fig. 3, *B* and *C*). When the palate is horizontal, the key ridge is l-like (Figs. 1 and 3, *A*). Anticipating a little, let us add that the key ridge is also Σ-like when the upper and lower faces are not equal in size and position (Fig. 16).

Table II. Correlation Between the Key Ridge and the Palate

OCCLUSION	—|	∧∨Σ	—Σ	∨|	TOTAL
N	30	9	7	4	50
I	12	6	2	0	20
II	9	6	3	2	20
III	4	5	1	0	10
Total	55	26	13	6	100

—: Horizontal palate.
∨: Concave palate.
∧: Convex palate.
|: Vertical key ridge.
Σ: Σ-like key ridge.

Correlation between the anterior cranial base and the palate: This is difficult to evaluate. The relationship is best seen when palatal contour, from ANS to PNS, is irregular (Figs. 17, 18, and 19). The irregularity in palatal contour seems to be matched with irregularity in anterior cranial base contour.

Synthesis.—The foregoing are the bony planes easily picked up in the lateral x-ray films. We may add another one—the occlusal plane. We are aware that these planes are not geometrically ideal, but for the sake of our study we will assume them to be geometric planes, bearing always in mind the observations already made concerning their individual variation in shape.

Relationship between mandibular base plane, occlusal plane, palatal plane, and anterior cranial base plane (Fig. 1): If we prolong these planes on a lateral

Fig. 3.—Different shapes of palate. *A*, Horizontal; *B*, convex; *C*, concave.

x-ray tracing, they all meet together posteriorly at the same point O in a well-proportioned face. This is not only a condition, but also the definition of such a face.

Relationship between point O and the bony profile of a well-proportioned face (Fig. 1): If we draw a circle from O as a center, and with O-ANS as the radius, we find that it passes through: pogonion, the incisal edge of the upper central incisor, the anterior nasal spine, nasion, and the fronto-ethmoid junction (x-ray projection). In other words, all these points are equidistant from point O.

Posterior relationship in a well-proportioned face (Figs. 1 and 4): If, from point O as a center, we draw a circle passing through the posterior wall of sella turcica (S^p), it also passes through gonion. Therefore, we can say that (1) the gonion and the posterior wall of sella turcica are equidistant from O and (2) since the radii in the preceding two paragraphs mark equidistant points, it is to be noted that anterior cranial base and corpal length of the mandible are equal in length and position (as referred to point O).

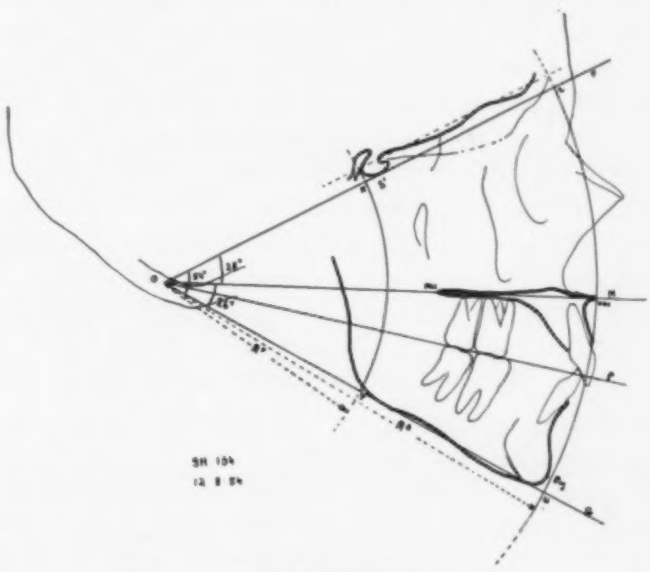
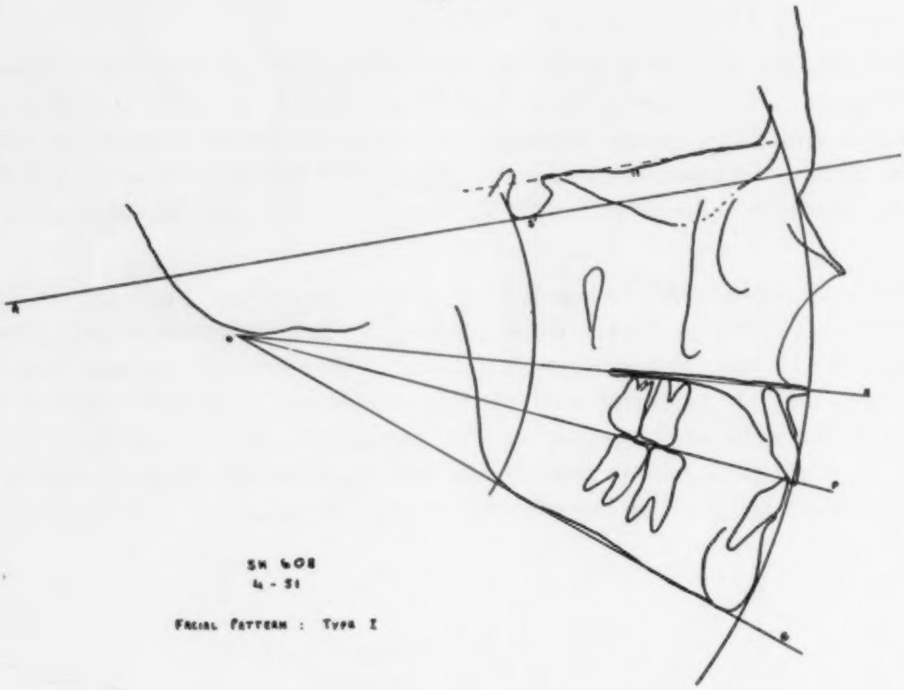


Fig. 4.—*KL-ANS-UT,* Facial limits.

Relationship between anterior and posterior arcs in a well-proportioned face (Figs. 1 and 4): The face is delimited: above, by the anterior cranial base plane; below, by the mandibular base plane; anteriorly, by the arc passing through ANS; and posteriorly, by the arc passing through S^p. The proportion between anterior and posterior arcs is a function of (1) angle S′O G and (2) the ratio of both radii $\frac{\text{Ra (O-ANS)}}{\text{Rp (O-SP)}}$.

The combination of S′O G and $\frac{Ra}{R^p}$ is the *facial index.*

Fig. 5.



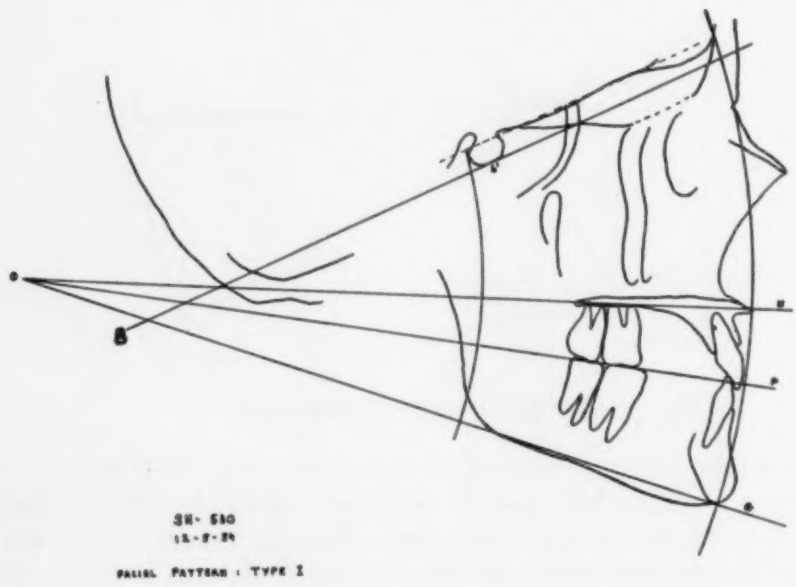


Fig. 6.

Fig. 5.—Facial pattern Type IA.
Fig. 6.—Facial pattern Type IB.

Relationship between the angles formed at point O (Figs. 1 and 4): The angle S′O G (the angle formed by the mandibular base plane and the anterior cranial base plane or mandibulocranial angle) is unique to each individual face. The angle S′O N (the angle formed by the anterior cranial base plane and palatal plane or palatocranial angle) is equal to the angle N O G (the angle formed by palatal plane and mandibular base plane or palatomandibular angle) S′O N = N O G. The angle N O P (the angle formed by the occlusal plane and the palatal plane, or the occlusopalatal angle) is between 1/1 and one-half the occlusomandibular angle: angle N O P equals 1/1 to one-half angle P O G. In other words, angle P O G is always larger than angle N O P in a well-proportioned face.

Definition and Classification.—

Definition: To the concept of a norm or a standard we wish to add the concept of proportionality. We shall define a well-proportioned face as one in which backward prolongations of the following planes all meet in a common point O (Fig. 1): the anterior cranial base plane, the palatal plane, the occlusal plane, and the mandibular base plane. This complex permits us to attempt a classification of facial types with varying degrees or patterns of proportionality.

Classification of facial types: The various facial types may be classified as follows: Type I (Figs. 5 and 6), wherein the anterior cranial basal plane does not meet the three other planes at the common point O; Type II (Fig. 7), wherein the palatal plane does not meet the three other planes at the common point O; Type III (Fig. 8), wherein the occlusal plane does not meet the three other planes at the common point O; and Type IV (Fig. 9), wherein the mandibular base plane does not meet the three other planes at the common point O.

Subdivisions: In each of these types, the plane which does not meet the three others at point O may pass either (A) above or (B) below that point. We will, therefore, add to Types I, II, III, and IV, the letter A or B, according to the position of the plane. For example, in Fig. 5, we have a facial pattern Type IA; in Fig. 6, we have a facial pattern Type IB.

Data: In our study of 100 lateral x-ray films we have found sixteen with a well-proportioned facial pattern. All these have normal occlusion. On the other hand, none of the cases of malocclusion has a well-proportioned face.

The others are reported as shown in Table III, which gives frequencies between facial pattern and occlusal categories.

TABLE III. FACIAL PATTERN AND OCCLUSION

FACIAL PATTERN	OCCLUSION				TOTAL	
	NORMAL	CLASS I	CLASS II	CLASS III		
Well-proportioned	16	–	–	–	16	16
I A	4	1	6	2	13	24
B	5	3	3	0	11	
II A	4	1	1	2	8	27
B	9	6	4	0	19	
III A	3	1	0	0	4	12
B	4	1	2	1	8	
IV A	3	6	3	5	17	21
B	2	1	1	0	4	
Total	50	20	20	10		100

Fig. 7.

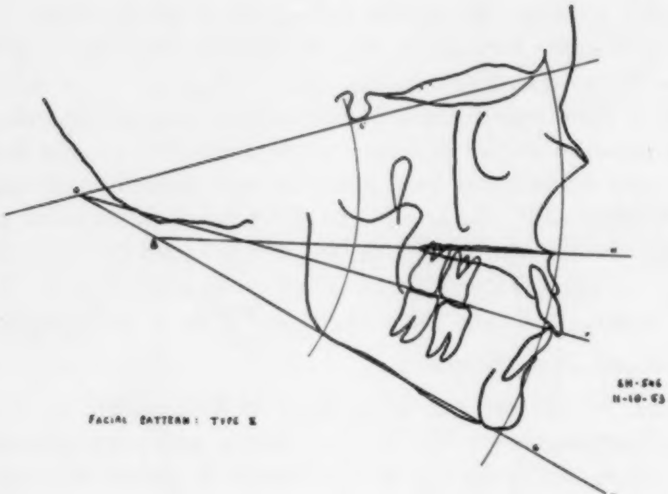


Fig. 8.

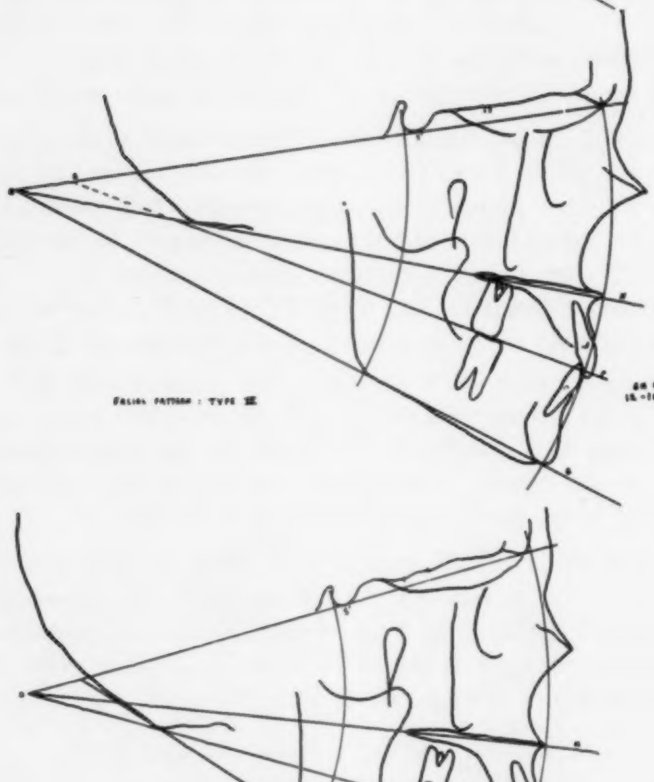


Fig. 9.

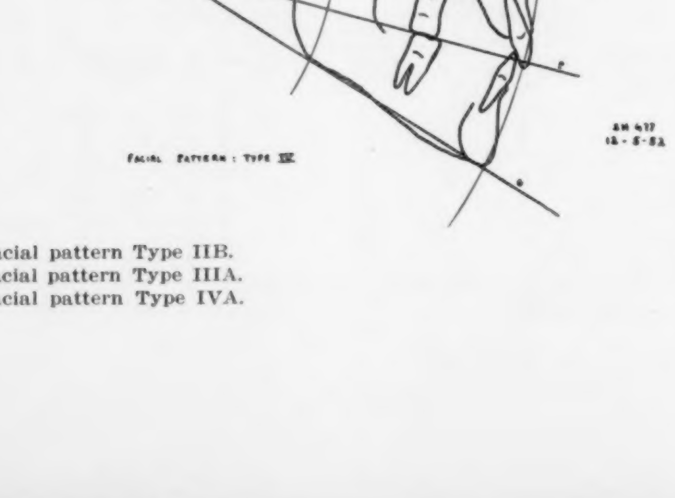


Fig. 7.—Facial pattern Type IIB.
Fig. 8.—Facial pattern Type IIIA.
Fig. 9.—Facial pattern Type IVA.

The major conclusions here are: (1) A well-proportioned face, as determined by our criteria, has normal occlusion. (2) Normal occlusion, as defined by Angle, is the condition necessary but not sufficient for a well-proportioned face. Among our fifty cases with normal occlusion, only sixteen have well-proportioned faces. (3) Type II facial pattern, in our sample, is the most frequent.

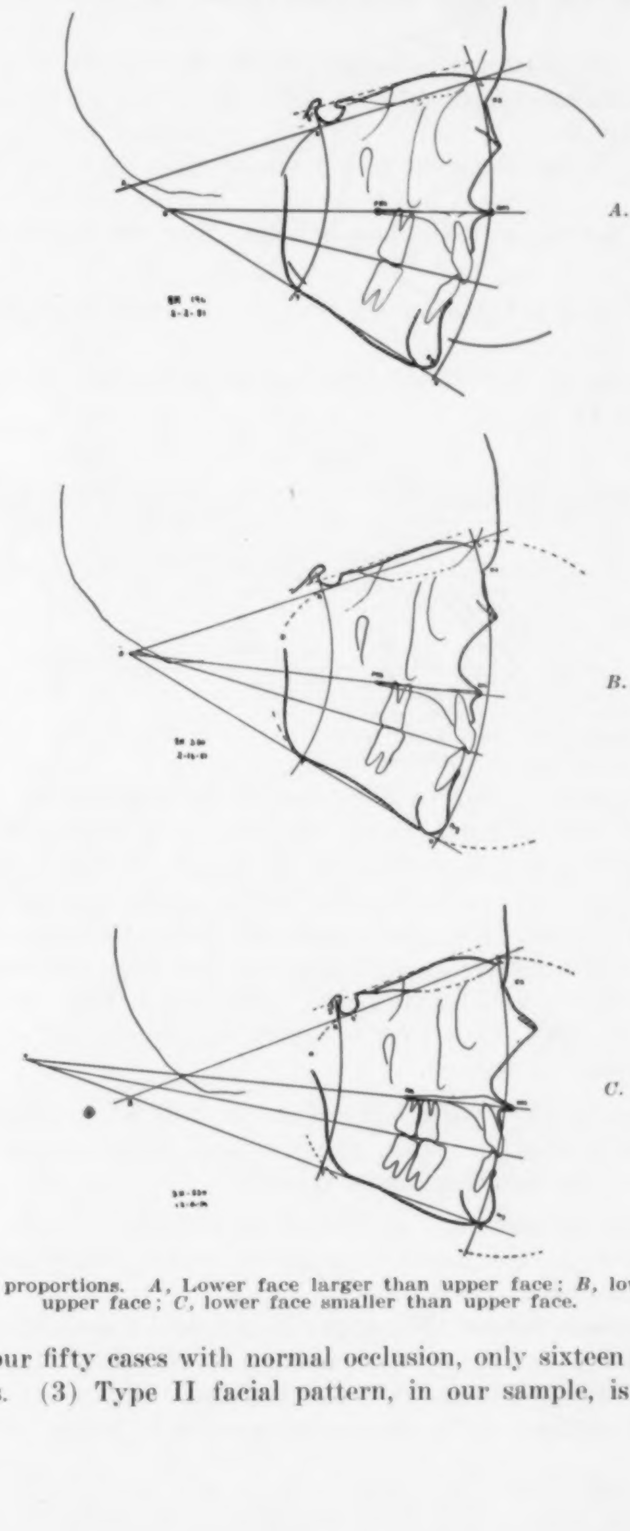


Fig. 10.—Vertical proportions. *A*, Lower face larger than upper face; *B*, lower face equal to upper face; *C*, lower face smaller than upper face.

Vertical Proportions.—We have already defined the anteroposterior structural relationships of the face. In like manner we will establish a classification based upon the vertical proportions (anterior and posterior).

Basically, we will compare lower face (below the palatal plane) to upper face.

I. *Equal:* The distance from ANS to the mandibular plane is equal to the distance from ANS to the cranial base plane, on the arc (Fig. 10, *B*).

II. *Minus:* Where the lower face is smaller than the upper face (Fig. 10, *C*).

III. *Plus:* Where the lower face is larger than the upper face (Fig. 10, *A*).

The classification is based on ANS for the anterior face and PNS for the posterior face.

In our sample the correlation between occlusion and vertical proportions is shown in Table IV.

TABLE IV

ANTERIOR VERTICAL PROPORTIONS					POSTERIOR VERTICAL PROPORTIONS				
FACIAL PATTERN	E	+	−	TOTAL	FACIAL PATTERN	E	+	−	TOTAL
N	14	18	18	50	N	23	9	18	50
I	9	10	1	20	I	13	4	3	20
II	6	9	5	20	II	9	2	9	20
III	2	4	4	10	III	2	1	7	10
Total	31	41	28	100	Total	47	16	37	100

E = Lower face equal to upper face.
+ = Lower face larger than upper face.
− = Lower face smaller than upper face.

A highly interesting finding is the correlation between the facial patterns and the anterior vertical proportions. Facial pattern Types IA and IIB have a lower anterior face that is larger than the upper. Facial pattern Types IB, IIA, and IVB have a lower anterior face that is smaller than the upper. Facial pattern types IIIA and IIIB have upper and lower faces which are approximately equal. Facial pattern type IVA may have a lower face larger or smaller than the upper face. This suggests that if Types IA, IIB, IB, IIA, and IVB are dependent on ANS, Type IVA is caused by the position of either menton or gonion (vertically speaking).

Classification of the Profile.—Based on the anterior arc and the points of reference on the profile (Na, ANS, upper incisor, pogonion), we may establish a classification of the different profile types:

I. *Archial:* by definition, we will call an archial profile the one where the anterior arc passes through Na, ANS, upper incisor edge, pogonion (Fig. 11, *B*).

II. *Prearchial:* Where ANS, upper incisor, and pogonion are situated anterior to the anterior arc passing by Na (Fig. 11, *A*).

III. *Postarchial:* Where ANS, upper incisor, and pogonion are situated posterior to the anterior arc passing by nasion (Fig. 11, *C*).

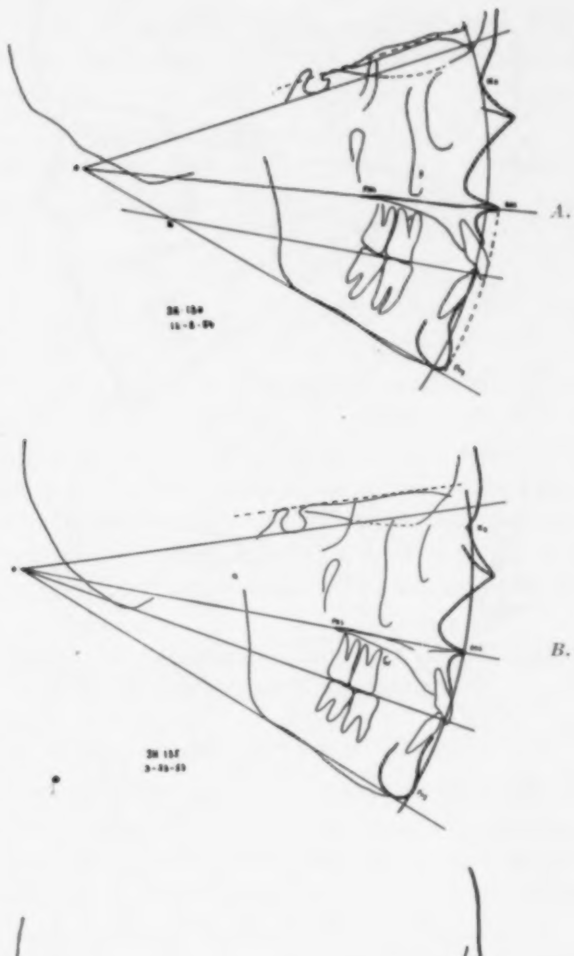


Fig. 11.—Types of profile. *A*, Prearchial; *B*, archial; *C*, postarchial.

A.

B.

C.

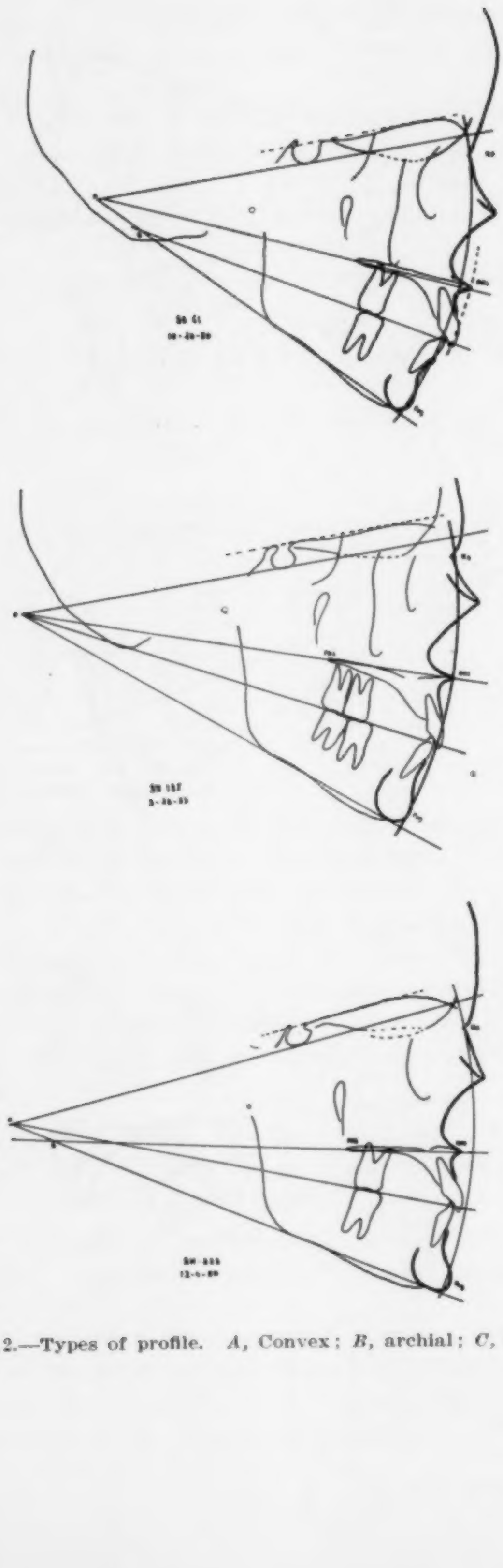


Fig. 12.—Types of profile. *A*, Convex; *B*, archial; *C*, concave.

IV. *Convex:* Where ANS and the upper incisor are situated anterior to the anterior arc passing by Na and pogonion (Fig. 12, *A*).

V. *Concave:* Where ANS and the upper incisor are situated posterior to the anterior arc passing by Na and pogonion (Fig. 12, *C*).

Table V shows the frequencies between the profile types and the different classes of malocclusion.

TABLE V. PROFILE AND OCCLUSION

OCCLUSION	ARCHIAL	PREARCHIAL	POST-ARCHIAL	CONVEX	CONCAVE	TOTAL
Normal	19	6	11	3	11	50
Class I	6	1	7	2	4	20
Class II	6	2	4	5	3	20
Class III	0	0	0	1	9	10
Total	31	9	22	11	27	100

Conclusion of Facial Study.—A complete, well-proportioned face, as seen on the lateral x-ray film, is the one (Fig. 1) in which (1) the four facial planes meet at the same point O, (2) the anterior upper and lower faces are equal, (3) the posterior upper and lower faces are equal, (4) the profile is archial (the anterior arc passes through Na-ANS-upper incisor and pogonion), and (5) the posterior arc passing through dorsum sella passes through gonion (the corpus of the mandible is equal in size and position to the anterior cranial base, comparative to the palatal plane).

We see, therefore, that there can be numbers of well-proportioned faces, as it is a question of proportion and not of absolute size.

TEETH AXES AND FACIAL PLANES

On a lateral x-ray film the teeth which are the most significant because of their eruption age, their clear image, and their early extreme position (anteriorly and posteriorly on the dental arch) are the upper and lower first permanent molars (later second molars were considered) and the upper and lower central incisors. We will base our study on these teeth ($\overline{1}$-$\overline{6}$ and $\underline{1}$-$\underline{6}$).

The following findings are based mainly on the study of the sixteen children with well-proportioned faces who also combine a normal occlusion.

Maxilla (Fig. 1).—

1. The axes of $\underline{6}$ and $\underline{1}$ intersect at the level of the bony orbital contour, as seen in lateral view (Fig. 1, point x).

2. They form, with the palatal plane, a triangle whose palatal angles have the following relationship: angle M′ = angle I′ + 10 degrees. (M′ is the angle formed by the $\underline{6}$ axis and the palatal plane, and I′ is the angle formed by $\underline{1}$ and the palatal plane.) Now, if we note that the $\underline{3}$ axis forms with $\underline{1}$ an angle of nearly 10 degrees, we may conclude that the $\underline{6}$ axis and the $\underline{3}$ axis form a perfect isosceles triangle with the palatal plane. This means that the best stability and balance (functionally and mechanically speaking) are realized when the axes of the maxillary teeth form an isosceles pyramid* whose base is

*The use of the word pyramid suggests a three-dimensional relationship, since transverse relations must also be considered.

the palatal plane. We shall use the $\underline{1}$ axis, however, since it fulfills the requirements just given. Therefore, we retain the equation, angle M′ = angle I′ + 10 degrees, keeping always in mind the key role of $\underline{3}$.

Mandible (Fig. 1).—

1. The ramal plane and the $\overline{1}$ axis form, with the occlusal plane, an isosceles triangle. Angle R = angle i. (Angle R is formed by the occlusal plane and the ramal plane; angle i is formed by the occlusal plane and the axis of $\overline{1}$.)

2. The axes of $\overline{6}$ and $\overline{1}$ form a triangle, the base of which is along the mandibular border. The angle formed by the axis of $\overline{6}$ (angle m′) is related to the angle formed by the axis of $\overline{1}$ (angle i′), so that m′ = i′ + 5 degrees. (The remarks made for the upper canine apply here too.)

3. The axis of $\overline{7}$ is parallel to the axis of $\overline{1}$ ($\overline{7}$ // $\overline{1}$).

We have thus pointed out the relation of the teeth to their bony base—the maxillary teeth to the palatal plane, the mandibular teeth to the mandibular base plane (in other words, to their immediate adjacent planes).

Relationship Between Teeth Axes and Other Planes (Fig. 1).—

1. If we prolong the $\underline{6}$ and $\underline{1}$ axes so that, after crossing each other at point X, they intersect the anterior cranial basal plane, we find that the newly formed triangle, I″XM″, is similar to the triangle, IXM, formed by the $\underline{6}$ and $\underline{1}$ axes with the occlusal plane. As a result, reciprocally, angle I″ equals angle M, and angle I equals angle M″.

2. If we prolong the $\overline{1}$ axis anteriorly so that it intersects the palatal plane, we find that the angle formed (iNI′) is equal to the angle formed by the upper incisor and the occlusal plane (OII′). In other words, the axial inclination of the lower central incisors to the palatal plane is the same as the axial inclination of the upper central incisor to the occlusal plane.

At each step we see that the interactions and the interrelations are getting more and more complex. A disturbance in any part of the face is reflected in the whole structure.

GROWTH STUDY

The preceding analysis enables us to study facial growth. employing a new method of superimposing the tracings of lateral x-ray films.

We shall use the point 0 as the fixed point.

There are two possibilities without orthodontic treatment: (1) the facial angles remain the same throughout growth or (2) the facial angles change during growth.

The Facial Angles Do Not Change (Fig. 13, SH-101).—Here we see that the four planes superimpose one upon the other and that none of the angles at 0 change. This is a case of a well-proportioned face and well-proportioned growth. The relationship between upper and lower faces (above and below the palatal plane) and anterior and posterior faces (limited by the two arcs) grows proportionately in every part.

The amount of growth can be easily calculated. Between the first and the second tracings, the only change is in the length of the radii. Therefore, the

growth proportion is equal to the proportion between the radii. If we call R_1 the radius O-ONS$_1$ and R_2 the radius O-ANS$_2$, the growth index between Nov. 13, 1951 (13:1) and March 2, 1954 (15:5)* is equal to $\frac{R_2.}{R_1}$ In this example it is true for horizontal as well as vertical growth, as the face is well proportioned.

The Facial Angles Change (Fig. 14, SH-297).—This is a Type IB facial pattern with good occlusion. Looking at the tracing of Nov. 1, 1950 (11:10),

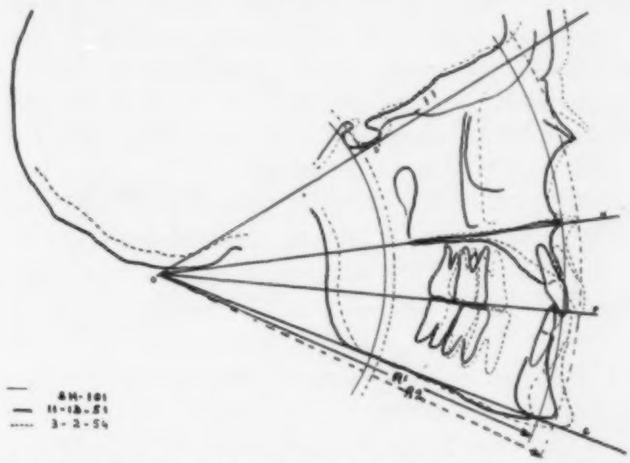


Fig. 13.—Well-proportioned face; well-proportioned growth.

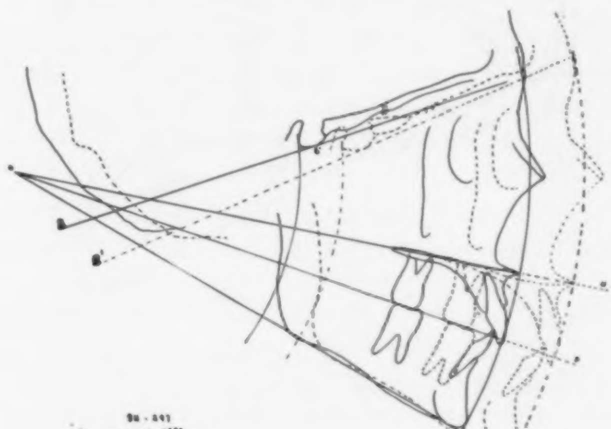


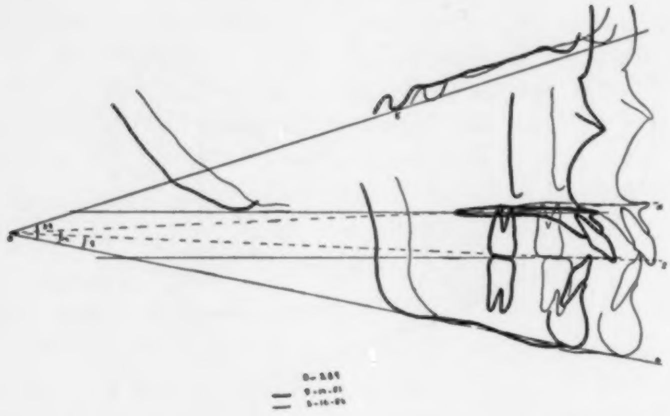
Fig. 14.—Type IB facial pattern; nonproportioned growth.

we see at once that there is a disharmony between the upper and the lower faces. This is due to the fact that the proportion between the anterior upper face and the posterior upper face is not equal to the proportion between the anterior lower face and the posterior lower face. In other words, (1) the angle formed by the basal plane and the palatal plane is not equal to the angle formed by the occlusal and mandibular base planes and (2) the four planes do not meet at

*The figure in parentheses, as 13:1, is for chronological age; that is, 13 years, 1 month.

the same point, $\underline{0}$. When we superimpose the second tracing of Feb. 10, 1953 (14:1) on the first, we see that (1) the lower face has grown in the same proportion in all the dimensions (horizontal and vertical); (2) in the upper face there is a lack of growth posteriorly (between sella and palatal plane); and (3) while the palatal plane has not changed, the shape of the palate has become more convex.

Fig. 15.



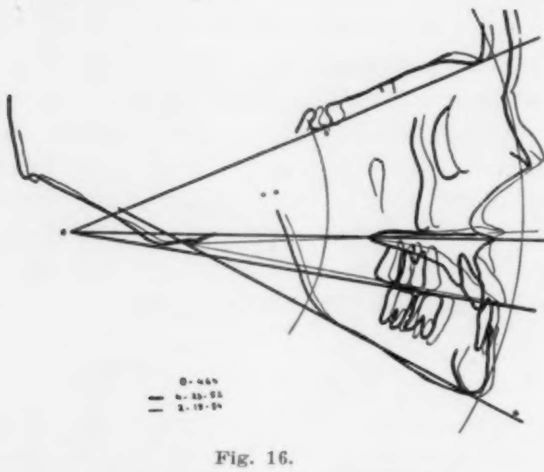


Fig. 16.

Fig. 15.—Class II malocclusion before and after treatment.
Fig. 16.—Class III malocclusion before and after treatment.

Let us now examine the changes during orthodontic treatment. The first example is that of a class II malocclusion (Fig. 15, O-289). Fig. 15 shows the superimposed tracings on angle $\underline{0}$ before and after treatment. Here we see that treatment has resulted in both a normal occlusion and a well-proportioned face. After treatment, (1) the four planes intersect at the same point; (2) upper $\underline{6}$ and $\underline{1}$ form more nearly an isosceles triangle above the palatal plane and are in good relationship with the basal plane; (3) the lower $\overline{6}$ and $\overline{1}$ form an almost perfect isosceles triangle with the mandibular plane; (4) the facial arc is within $\pm$ 1 mm. from pogonion, $\underline{1}$, ANS, Na.; (5) besides the dental change, the main change in the bony structure is in the palate. We see that the palatal

plane has been tipped downward posteriorly. This is due less to the posterior nasal spine than to the ANS, which is proportionally higher than in the first tracing; in other words, the anterior upper and lower faces are in better proportion.

The second example is that of a Class III malocclusion (Fig. 16, O-464). In these superimposed tracings we see that: (1) Treatment and growth have not changed the angle formed by the anterior cranial basal plane and the mandibular base plane. This means that the over-all growth between these two planes (anteriorly and posteriorly) has been proportionate. (2) The angle formed by the occlusal plane and palatal plane has opened up. This means that, within these two planes, the anterior vertical segment has grown proportionally more than the posterior one. The second ANS is higher now than the first one. This change may be attributed to orthodontic treatment. (3) The face is not well proportioned because the four planes do not intersect at the same point, O. (4) ANS and 1 are still posterior to the facial arc (drawn here by reference to pogonion and nasion to show that this Class III malocclusion is due to an underdevelopment of the maxilla and not an overdevelopment of the mandible).

As stated before, the anterior cranial base is equal to the corpus of the mandible, which is what we see here. This brings us to a more practical subject: ***how to make a diagnosis with this analysis and how to decide on a treatment plan.***

SOME THOUGHTS ON TREATMENT PLANNING

In the following examples, our recommendations as to treatment in each case have been dictated solely by our analytic concepts. It should be understood that this is an ideal and theoretical treatment. We have not discussed what is possible and how; in other words, we have not considered the limitations of orthodontics.

For example, when we say that the premaxillary area and ANS should be brought downward we do not consider the way of doing it or the best time to do it.

We must remember that in our specialty appliances have been invented and perfected to meet the need of a certain type and a certain philosophy of treatment. Let us think for a while about the expansion arch wire, the tip back bends, and the occipital anchorage.

Let us also be aware that the basic question—"Can we modify the facial structure by orthodontic appliance?"—has not been answered yet. The reports are based on a limited number of treated cases, of patients within a limited age range treated by a specific appliance.

In diagnosis, three viewpoints are possible:

1. A specific face can be compared to an ideal, and the decision is made by the orthodontist.

2. A specific face can be compared to an average face (based on the concept that the majority is the normal), and the type is derived from the majority of people.

3. A specific face can be compared to the optimum for that specific face, as presented in this analysis. Here, the decision is set by the architecture of the patient's face itself.

We emphasize that no single viewpoint has the complete answer. A combination or synthesis of all three would come nearer an ideal interpretation in a given case.

DIAGNOSTIC AND TREATMENT PLAN

The diagnosis should always be carried in the following sequence: (1) determination of the malocclusion (independently of the determination of the malocclusion by clinical examination); (2) study of the facial proportions by means of the planes and arcs; and (3) study of the axial inclination of the teeth and their relation to the planes. The best way to demonstrate the foregoing is by examples.

Study of Facial Proportions.—The first example is Case O-276 (Fig. 17).

Occlusion: Class II, Division 1.

Facial pattern: By drawing the four planes, we see that this case is a Type IIB.

Anterior arc: With 0 as center and 0-ANS as radius, we draw the anterior arc. In this case it is in front of pogonion; posterior to the incisal edge of $\underline{1}$, and posterior to nasion. Quantitatively, the major malposition is in the pogonion.

Posterior arc: With 0 as center and 0-S^p as radius, we draw the posterior arc. It intersects the mandibular base plane anterior to the gonion.

Vertical balance: We have found that in a well-proportioned face the palatal plane should be equidistant from the anterior cranial basal plane and the mandibular base planes. In this case, we have to determine the site of the disproportion, at ANS or PNS.

1. *ANS*—must be at the midpoint of the anterior arc. Thus, if from ANS as center and the upper anterior arc as radius, we draw a circle (plain circle) we see that, in the lower face, it intersects the anterior arc above the mandibular base plane. In other words, the anterior upper face is shorter than the lower one.

2. *PNS:* If we draw a circle from PNS as center and PNS K as radius, it will intersect the posterior arc very close to the mandibular base plane. In other words, the posterior upper face is equal to the posterior lower face.

3. *Palatal shape:* Note that the palate is convex. If we draw the plane of the posterior part of the palate (dotted line), it divides the anterior arc (dotted circle) more equally.

Diagnostic findings: (1) Horizontally, this is a Class II malocclusion due to the posterior position of the mandible. The maxilla is well situated. (2) Vertically, ANS and the anterior portion of the palate (premaxilla or incisal bone) are too high.

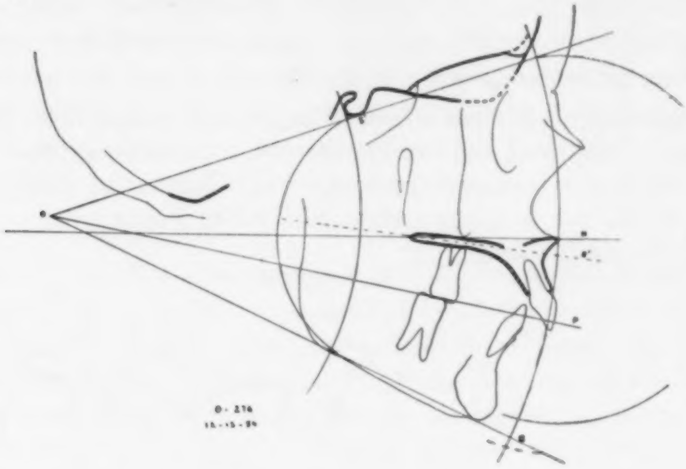


Fig. 17.

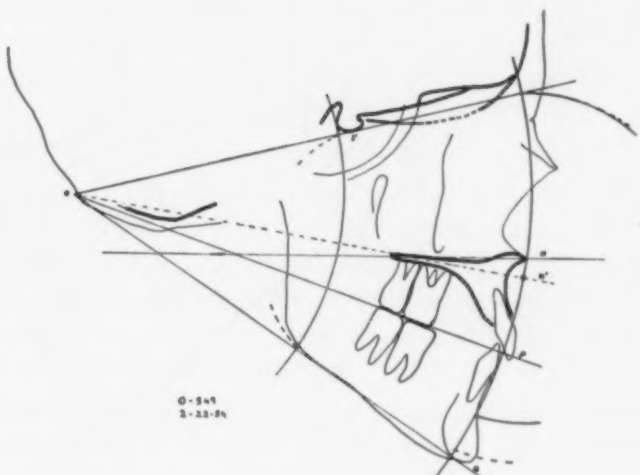


Fig. 18.

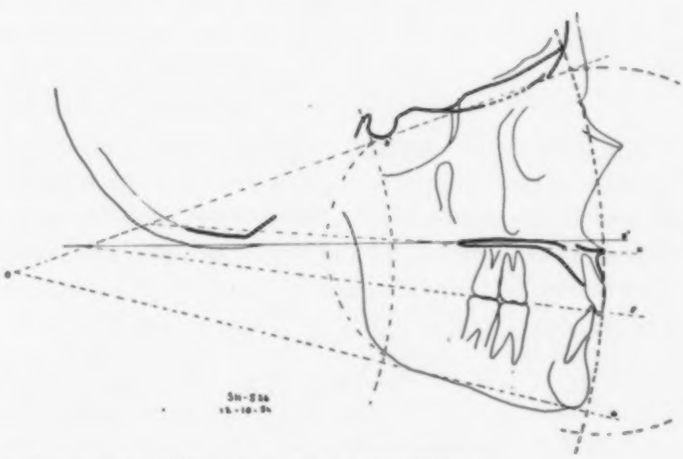


Fig. 19.

Fig. 17.—Study of horizontal and vertical proportions.
Fig. 18.—Analysis of a Type IIB facial pattern.
Fig. 19.—Plane analysis.

Treatment: (1) Bring the mandible forward, since both pogonion and gonion are posterior in position; and (2) bring the premaxillary area downward, since there is an imbalance between upper and lower anterior face heights.

The second example is Case O-549 (Fig. 18), a similar Type IIB face with a convex palate, oversized but well-positioned mandible, anterior upper face smaller than the lower, and posterior upper and lower face equal. Treatment is mainly to bring the anterior palate and ANS downward; the dotted line shows where to bring the ANS.

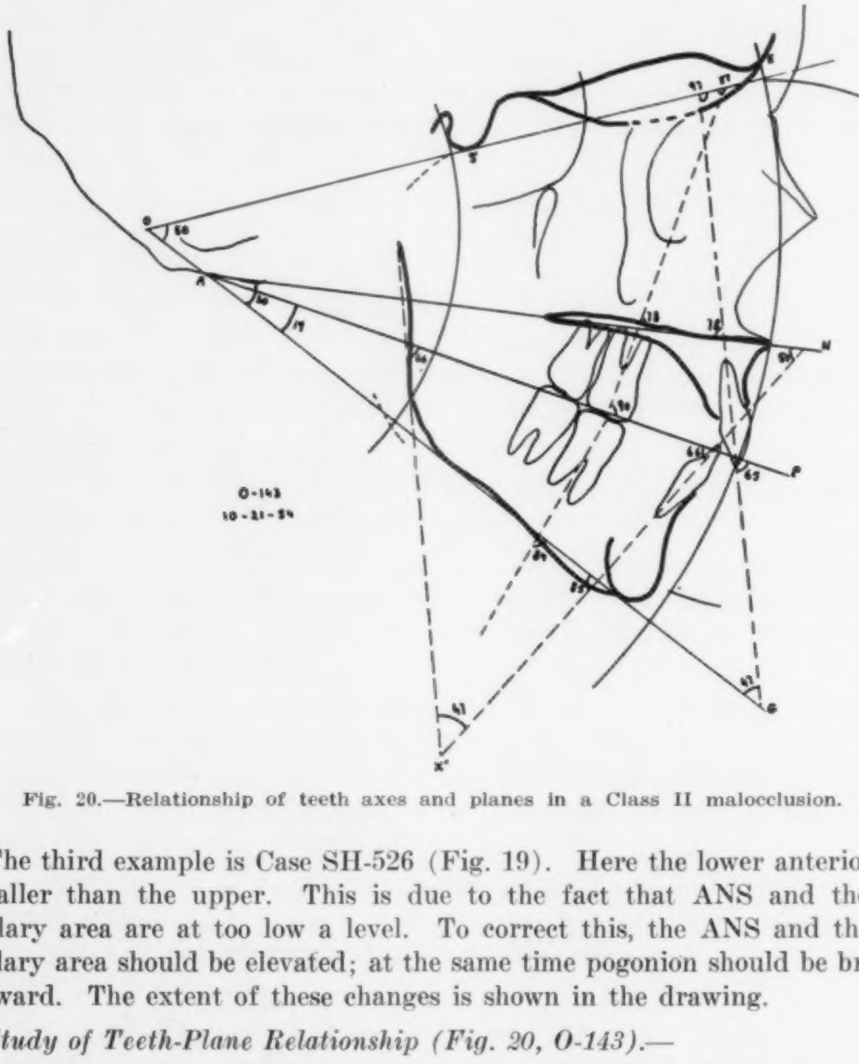


Fig. 20.—Relationship of teeth axes and planes in a Class II malocclusion.

The third example is Case SH-526 (Fig. 19). Here the lower anterior face is smaller than the upper. This is due to the fact that ANS and the premaxillary area are at too low a level. To correct this, the ANS and the premaxillary area should be elevated; at the same time pogonion should be brought downward. The extent of these changes is shown in the drawing.

Study of Teeth-Plane Relationship (Fig. 20, O-143).—

Skeletal analysis: This patient has a Type IA face. Only the pogonion is posterior to the anterior arc. The posterior arc passes behind the gonial angle. The anterior upper face is smaller than the lower; the posterior lower face is smaller than the upper. The proportion between the anterior and posterior upper arcs is not equal to the proportion between the anterior and posterior lower arcs.

Skeletal diagnostic observations: The length of the corpus of the mandible is smaller than the anterior cranial base. ANS is situated too high.

Treatment: We cannot directly change the anterior cranial base plane. Therefore, although this patient has a Type IA facial pattern, we will consider it as a Type II face and try to correct the disproportion by bringing the palatal and occlusal planes to point $\underline{0}$; that is, we will bring the ANS downward.

Teeth axial inclination:

A. *Maxilla:* (1) We have angle M′ = 78 degrees and angle I′ = 78 degrees; we should have angle M′ = angle I′ + 10 degrees. Now, if we lower ANS and keep PNS in place so that the palatal plane meets point $\underline{0}$, angle M′ will be opened and angle I′ will be closed to the exact amount needed. (2) We have angle M = 90 degrees and angle I = 65 degrees; and angle I″ = 97 degrees and angle M″ = 57 degrees. We should have angle M = angle I″ and angle I = angle M″. Now, if we lower the anterior portion of the occlusal plane by depressing the lower incisors, we will have the occlusal plane passing through 0. Thus, angle M will be opened up and will be equal to angle I″, and angle $\overline{I}$ will be closed up and will be equal to angle M″.

B. *Mandible:* (1) We have angle R = 66 degrees and angle i = 66 degrees, which is exactly what we should have. The new occlusal plane, passing through $\underline{0}$, will close angle R and open angle i. Therefore, in order to keep the equality, angle R = angle i, we have to tip the crown of the $\overline{1}$ labially until it meets $\underline{1}$ (which should not be tipped lingually, because its incisal edge is well placed on the anterior arc). (2) We have angle i′ = 85 degrees and angle m′ = 84 degrees. We should have angle m′ = angle i′ + 5 degrees.

This will be corrected (a) by tipping $\overline{1}$ crown labially (angle i′ will close) and (b) by tipping $\overline{6}$ crown mesially (angle m′ will open), correcting at the same time the Class II malocclusion. In this case, the mandible must not be brought forward, as the corpus is smaller than the anterior cranial base and is located between anterior and posterior arcs.

The preceding examples, we feel, have demonstrated that our analysis has provided a basis of both diagnosis and treatment planning.

We must emphasize again that absolute measurements have less meaning than proportions, this is the main reason we do not present extensive statistical data. We prefer to replace the concept of arithmetic normality by the concept of proportionality, seen more clearly and simply by the drawing.

FACIAL PATTERN AND MALOCCLUSION

We have stated previously that, if a malproportioned facial pattern can be associated with good occlusion, we have not found any well-proportioned facial pattern associated with malocclusion.

Class II Malocclusion and Facial Pattern.—In the course of this study, we especially analyzed Class II cases. Our twenty cases of Class II malocclusion can be classified in two major groups according to their facial pattern.

The first group may have either a facial pattern Type IIB (Fig. 17, O-276) or Type IVA (Fig. 23, PS-29). Their common facial characteristic is:

ratio $\dfrac{\text{lower anterior face}}{\text{lower posterior face}}$ greater than ratio $\dfrac{\text{upper anterior face}}{\text{upper posterior face}}$,

or $\dfrac{LAF}{LPF} > \dfrac{UAF}{UPF}$.

The second group may have either a facial pattern Type IIA (Fig. 15, O-289) or Type IVB (Fig. 19, SH-526). Their common facial characteristic is:

ratio $\dfrac{\text{lower anterior face}}{\text{lower posterior face}}$ less than ratio $\dfrac{\text{upper anterior face}}{\text{upper posterior face}}$,

or $\dfrac{LAF}{LPF} < \dfrac{UAF}{UPF}$.

Treatment Plan.—The recognition of two groups of Class II malocclusion is very important for diagnosis and treatment planning.

While in the first group we have to either increase the lower posterior facial height or decrease the lower anterior facial height, in the second group we have to either decrease the lower posterior facial height or increase the lower anterior facial height.

This demonstrates anew our feeling that "the absolute measurements, averages, and mean values are less significant than proportions."

Most of the studies done on Class II malocclusion have not taken into consideration the different groups of Class II. The groups just mentioned are differentiated according to their vertical proportions. Two other groups of Class II malocclusion also can be established according to their anteroposterior relationship: Either the mandible can be posteriorly placed (Fig. 17, O-276) or the maxilla can be anteriorly situated (Fig. 12, *A*, SH-61). Now, if we take these four groups of Class II and take any kind of absolute measurements and reduce them to mean values, they will be very close to those of a perfect occlusion, with a very large standard deviation. Thus, the mean values are not significant.

THIRD DIMENSION: MODEL ANALYSIS

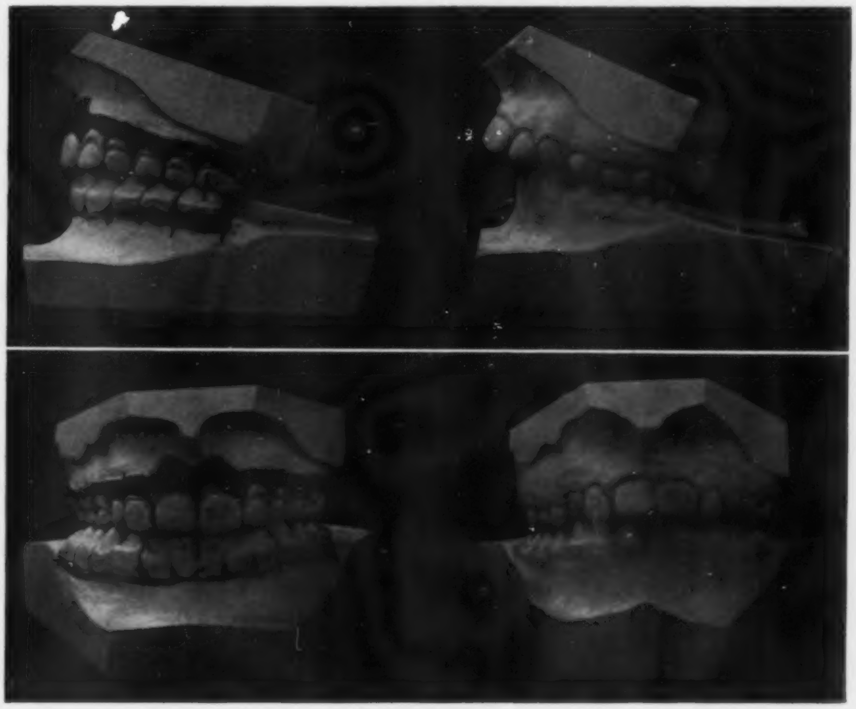
After all that we have said about cephalometrics, we must insist that a clinical examination is basic to the understanding of the total occlusal picture. The link between the x-ray films and the clinical examination is the model. In other words, to this two-dimensional analysis (the lateral x-ray) we will add a three-dimensional model. We have seen, in our study, the importance of the four facial planes. Among those, three are in a direct relationship to the teeth: (1) the palatal plane, (2) the occlusal plane, and (3) the mandibular base plane. Therefore, these will be the reference planes that we shall use

(1) to trim the plaster models (Fig. 21) (the base of the maxillary model will have the same size as palatal length and direction as the palate, and the base of the mandibular model will have the same size

as the corpal length and the same inclination as the mandibular base plane) and (2) to reposition the teeth according to our definitions of a well-proportioned face (Fig. 21) by bringing the three planes into the relationship mentioned before and, by bringing the teeth into normal occlusion so that they fill the requirements mentioned before concerning the relationship between their axial inclination and the facial planes. (See section on "Teeth Axes and Facial Planes.")

In this way, during the course of the treatment, we will have presented concretely the ideal goal which is our aim. In this way, also, we may have an answer to the problem of the possibility of extractions (including where extractions should be made and how many teeth should be removed). Brought to

A.



B.

Fig. 21.—Oriented models of a case with Class II malocclusion. *Right:* Models trimmed according to the proportional analysis. *Left:* Repositioning of the teeth and the planes according to the proportional analysis.

correct proportions and positions, the teeth and the planes will present the most harmonious balance, functionally and esthetically. Results will be more stable, thus avoiding possible relapse.

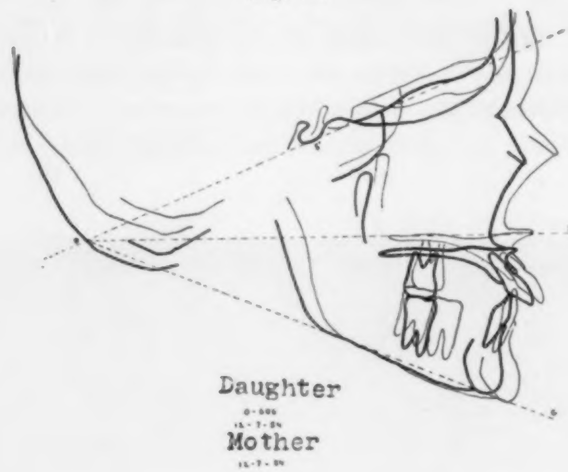
HEREDITARY IMPLICATIONS

Our study suggests that a cephalofacial architectural pattern may run in family lines. We have only twelve sets of lateral head x-ray films of parent

and child. The test of similarity between parent and child was the *parent's estimate of degree.* We felt that parental evaluation of the totality of similarity was sounder than our trait-for-trait analysis.

In comparing parent and child x-ray pictures, we superimposed tracings, 0 and 0 and facial planes upon facial planes (Fig. 22). We also compared brother and brother (Fig. 23). In this connection, we may cite Brodie's[4]

Fig. 22.



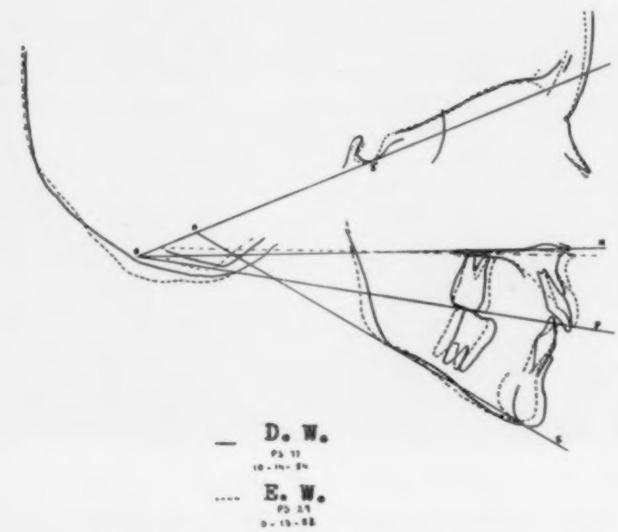


Fig. 23.

Fig. 22.—Superimposed tracings of a mother and her daughter.
Fig. 23.—Superimposed tracings of two brothers.

comparison of cephalometric contours of triplets. He noted similarities to the point of identities, using, for example, the N-S plane, the palatal plane, and the occlusal plane.

Our findings, in the twelve parent-child cases, may be summarized as follows: three have the same total facial angle; five have the same upper facial angle, NOS'; and four have the same lower facial angle, NOG.

This very preliminary excursion into family line pattern raises the following interesting problems:

1. Are craniofacial (referring to bone only) traits inherited as units or as complexes? In other words, is there a basic pattern?

2. Are accompanying soft tissue structures independent, or merely part of the underlying bony complex?

Of course, we cannot answer either of the questions, or any part of them, but we do feel that our system of proportional analysis lends itself to a reasonably clear-cut trait-pattern analysis.

CONCLUSIONS

While, in the first part of this study, most of the findings seem to imply that the architecture of the face is the result of functional forces, the later paragraphs regarding possible hereditary factors seem to suggest that the facial pattern may be inherited.

It seems, however, that the truth is between these two extremes—functional and hereditary. In a last analysis, therefore, we are back to the concept of the face as the battleground of diverse forces.

We have to admit that there is no universal normality; there is no norm which can be applied indiscriminately to everybody.

Racial differences, a first distinction of facial pattern, should be based on the characteristics of the Caucasian, Negroid, and Mongoloid races and their subdivisions.

Within these subdivisions, there is the influence of the specific familial hereditary force, or family line.

We see that the concept of "normal" becomes so complex that it cannot be absolute; it must be relative, considering all variable factors involved in, and contributing to, individuality.

This brings us to the individual himself, influenced by functional and environmental forces. We come to the concept that each individual person carries in himself all the potentialities for the best and for the worst; that he carries in himself his own ideal type, his optimum. Or, as Lamartine says, "*l'homme est un dieu tombé qui se osuvient des cieux*" ("man is a fallen god, who remembers heaven").

What are the conclusions for the orthodontist to draw from this concept? It may be a dangerous mistake to try to correct malocclusions by referring to absolute norms. To emphasize this, let us say, for example, that it will be a mistake and also a source of relapse to try to correct a Negro with our standards for the Caucasian race. Just the same, it will be a mistake and a source of failure if consideration is not given to the particular facial pattern of each of our patients. In this way of thinking, the proportional analysis that we have studied takes its full meaning.

Let us add that this analysis is not confined to the specialty of orthodontics, but is also potentially useful in the following fields:

1. ***Anthropology***. Here we may better understand primate relationships and human evolution. In *Homo sapiens* we may compare the racial differences and analogies.

2. *Prosthetics,* to determine the position of the occlusal plane and the axial inclination of the teeth.

3. *Oral surgery,* in planning mandibular resection or operation for cleft palate.

4. *Periodontics,* where selective grindings may change the occlusal plane.

5. *Genetics,* to study the transmission of facial traits or pattern through generations.

SUMMARY

1. This article is a contribution to roentgenographic cephalometrics. It is based, in principle, upon the assumption that, in an individual person, cephalofacial proportionality is achieved by a balance between certain growth loci or segments. We have sought, therefore, to elucidate a basic architectural pattern.

2. Our findings are based upon cephalometric x-ray films on file at the Philadelphia Center for Research in Child Growth. We have used 100 lateral headplates (fifty-one girls and forty-nine boys, mostly of the Mediterranean white race). Of these, fifty have normal occlusion, twenty have Class I malocclusion, twenty have Class II, and ten have Class III (Angle) malocclusions.

3. We have used four main horizontal planes of reference, each centering in an area of growth-adjustment. These are as follows:

a. *Cephalofacial* or upper.—Anterior cranial base plane.

b. *Midfacial.*—Palatal plane.

c. *Dental.*—Occlusal plane.

d. *Mandibular* or lower.—Mandibular base plane.

4. We hold that *a face is well proportioned* when the axes of these four planes, prolonged posteriorly, meet or intersect in a single common point, O. This point O is usually posterior to the occipital contour. The location of O may vary with age, closer to or within, the occipital contour in younger children, and farther or beyond, the contour in older children. This remains to be tested.

5. With the point O as a center, we establish two arcs: (a) *anterior,* with O-ANS as radius; and (b) *posterior,* with O-S^p as radius.

6. In a well-proportioned face, the anterior arc intersects, from above down, the frontoethmoid junction, nasion, anterior nasal spine, incisal edge of the upper central incisor, and pogonion.

7. Similarly, the posterior arc intersects the posterior wall of sella turcica and gonion.

8. The relation of our four planes to the common point 0 permits of the classification of four *facial types:*

Type I: Anterior cranial base plane does not pass through 0.
Type II: Palatal plane does not pass through 0.
Type III: Occlusal plane does not pass through 0.
Type IV: Mandibular base plane does not pass through 0.

9. Since, in each facial type, the deviant plane may pass above (A) or below (B) the point 0, we may recognize subtypes, as IA or IB and so on.

10. In our sample, we determined that a well-proportioned face invariably has normal occlusion. Normal occlusion alone, however, is not sufficient to define or establish a well-proportioned face.

11. The axial relation of upper and lower permanent teeth to the palatal plane and mandibular plane has been studied (upper Il and Ml, lower il and ml). Their respective relationships to the palatal plane and mandibular plane are such that angle $M' =$ angle $I' + 10$ degrees and angle $m' =$ angle $i' + 5$ degrees.

12. In other angular relationships we have found that the axial inclination of the lower incisors to the palatal plane is the same as that of the upper incisors to the occlusal plane.

13. We have found that the angle formed by the ramal plane with the occlusal plane is equal to the angle formed by the axial inclination of the lower central incisor with the occlusal plane (angle $R =$ angle i).

14. Via the serial case history method, we have analyzed facial angle relationships during growth and also during the course of orthodontic treatment. As a result of these procedures, we have presented a section entitled "Diagnostic and Treatment Plan," in which we outline the step-by-step application of our concepts of architectural harmony (proportionality).

15. Since we feel that cephalometric x-ray films are a means, rather than an end, we emphasize the basic importance of the clinical examination. In our thinking, the model is the best objective link between clinician and x-rays. Hence, we offer a method of trimming the casts that will orient the teeth to: (1) the palatal plane, (2) the occlusal plane, and (3) the mandibular base plane.

16. We suggest that our analysis is of potential value in phylogenetic studies, in family line inheritance studies, and in the allied dental fields of oral surgery, periodontics, and prosthetics. Pilot studies in these areas of investigation will be undertaken at the Growth Center in due time.

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THE DILEMMA OF UNDERGRADUATE ORTHODONTIC EDUCATION AND ITS EFFECT

WALTER G. SPENGEMAN, A.B., D.D.S.,* YONKERS, N. Y.

If a little knowledge is dangerous, where is the man who has so much as to be out of danger?—*Thomas Henry Huxley, on "Elemental Instruction in Physiology," 1877.*

THE purpose of this article is to discuss the problems of presenting the dental student with a background in orthodontics. The time allotted for this is, in general, absurdly inadequate. However, the thought is that by presenting a recapitulation of the problems, each of us may be a little better able to assay the underlying difficulties and thereby form an opinion of the responsibilities consequent to him.

It is easy for one to state that this is a problem for the trained teacher. This, of course, is true. Reflection will show, however, that the level of orthodontic cognizance of the general practitioner should be the concern of every practicing orthodontist.

The study and teaching of orthodontics did not spring full-blown from any single forehead; rather, it presents the picture of a gradual, painstaking process, covering a span of many years. It might be well, then, to consider the development of our specialty, to be better able to place ourselves at our present level of evolution. A brief history of the development of orthodontics in relation to our present status is therefore relevant.

HISTORY OF UNDERGRADUATE ORTHODONTIC TEACHING

In 1728, Fauchard published what LeRoy Johnson called "the earliest attempt in the literature at systematic treatment of orthodontia.'' In 1829, Bell, in his book, *Anatomy, Physiology and Diseases of the Teeth,* attempted to classify malocclusions on a basis of those associated with the deciduous dentition as against those related to the permanent dentition.

Norman Kingsley, generally considered the father of orthodontics, began to publish papers on the correction of dental irregularities as early as 1858. By 1872, he was lecturing to students, stressing the functional, as well as the esthetic, value of orthodontic treatment. His insistence on the biologic implications of malocclusion, with emphasis on the growth and development of the dental structures, was the beginning of a scientific approach to orthodontics. Kingsley

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also mentioned the effect of disease and habit formation as possible etiological factors in malocclusion. He was also among the first to utilize occipital anchorage in retracting maxillary incisors.

Eugene S. Talbot wrote articles on the manipulation of teeth by direct pressure as early as 1881. In 1888, his book entitled *Irregularities of the Teeth* was published. Talbot emphasized the "local and constitutional" causes of malocclusion, and his teachings became an integral part of many early lecture courses in the dental colleges. No serious effort had been made as yet to attempt orthodontic teaching at a postgraduate level. In 1889, a textbook on orthodontics was published by Simeon H. Guilford. It was used for approximately twenty years and had a far-reaching effect on early orthodontics.[14]

It was during these years (1880 to 1890), that the first real controversies on the extraction of teeth began. Most dentists had adopted the idea of extraction of teeth, but some few articulate men were violently opposed to this principle. Isaac B. Davenport was an early advocate of nonextraction of teeth. He wrote prolifically on the re-establishment of proper occlusion, emphasizing his contention that permanent results would not be achieved if teeth were removed.

One of Davenport's disciples was a young man named Edward Hartley Angle, who is generally accepted as the greatest figure in orthodontic history. No attempt will be made here to do proper credit to Dr. Angle and his contributions to our science, since that would be a task far beyond the scope of this article. From 1880 to 1889, he attempted to teach orthodontics in various dental schools (Minnesota, Northwestern, Marion Sims Medical College, and Washington University). During this time, he expounded the "Angle System of Regulating Teeth." He published the first edition of his book, *Malocclusion of the Teeth,* in 1886.

In 1889 Dr. Angle rejected all further university affiliations, having failed to interest the University of Pennsylvania and Northwestern University in forming a special department devoted exclusively to the study and practice of orthodontics. At the National Dental Association meeting at Niagara Falls in 1899, he interested four young men in spending three weeks with him at his office in St. Louis. Thus, the Angle School of Orthodontia was formed. This school graduated many of the most outstanding of our early twentieth century orthodontists from 1900 to 1911.[14, 15] The first course was only a few weeks in length, but it was gradually increased to a full calendar year. Dr. Angle required preliminary examinations in dental histology and anatomy of the head and neck. The courses that he gave included a broad biologic background: anatomy, comparative anatomy, histology, zoology, and even art. It is generally accepted that the founding of the Angle School of Orthodontia at the Academy of Science in St. Louis had a most profound influence upon the future of the profession. It is no exaggeration to state that this institution was largely responsible for the emergence of orthodontics as a specialty. However, entrance requirements for the school were high, as Dr. Angle sought students rather than mere technicians. Since the Angle School could not supply the demands for orthodontists, other schools sprang into being rather quickly.

Unfortunately, most of these schools did not require the preliminary basic biologic training, nor did they have the guiding genius of Dr. Angle. However, because of the pressing demands, and because ill health caused Dr. Angle to discontinue his course after 1911, other schools expounding a relatively mechanical type of teaching soon outnumbered the Angle School in graduates. It was dissatisfaction with the type of orthodontic teaching then existing as much as a return to health that caused Dr. Angle to organize the Angle College of Orthodontia after taking up residence in Pasadena, California. This course required from one to two years, and many of its graduates are among the present-day leaders of our profession.[23] Although the death of Dr. Angle in 1931 marked the end of an era in orthodontics, the impetus of his teaching will go on for many years.

However, it was during the early part of the century that the confusion and conflicting idiologies which might be called the "Arcana Age of Orthodontics" came about. Small groups of men isolated themselves to impound a particular type of philosophy or appliance therapy. These groups, excluding all others, guarded their secrets jealously and denounced and disparaged all ideas with which they did not agree. That this "Arcana Age" caused schisms and disharmony which lasted three or four decades is undeniable. Finally these janizaries of the old order passed from the scene and a group of more liberal-minded teachers took their places. It is due to this somewhat unfortunate beginning that the orthodontist of today is still occasionally credited with being a "quack" or a "racketeer" and unwilling to share his knowledge with others.[1, 2]

It was because of the general discredit with which the orthodontic graduate of the proprietary school was viewed by the profession at large that effort was made to bring orthodontic training within the university curriculum, first at the postgraduate level and then at the graduate level. Thus, we see that in many universities today orthodontics is taught in a graduate school of that university, which leads to a Master of Science degree, as well as a postgraduate course of a dental school, which leads to a "certificate of proficiency" or a "certificate of training."

It is not the purpose of this article to attempt an history of the study of orthodontics, but rather to review the history in terms of its effect on present-day undergraduate orthodontic training. Graduate and postgraduate training might be said to be "on their own," as they are relatively unhampered by the physical limitations which confront the planners of the undergraduate course. One must consider that the dental student is expected to acquire a reasonable degree of proficiency in the science of basic dentistry while in dental school. The curriculum is limited to 4,400 hours for a four-year dental course by the Council on Education of the American Dental Association. The time available for the pursuit of "orthodontic background" has been debated considerably,[4, 5, 7, 8, 11, 12, 19, 21, 26] but it is generally conceded by the most sanguine of our dental educators to be inadequate. The question is: What, if anything, can be done to improve this unhappy situation, and what is its effect on the average general dental practitioner?

THE DENTAL TEACHER AND THE ORTHODONTIC TEACHER

In this brief review of undergraduate orthodontic training, it becomes imperative to mention the monumental work done under the leadership of the Subcommittee on Teaching Orthodontics of the American Association of Dental Schools.[2, 3, 9, 16, 20, 25, 28, 29] It was shown that a considerable difference of opinion existed between the dental teacher and the teacher of orthodontics, the former advocating that the dental undergraduate be trained to provide advisory and preventive service and to treat the simpler cases of malocclusion; the latter avowing firmly that the present curricula permit training in prevention only.[20]

Many articles have been written discussing the relative merits of either course.[1, 5, 6, 11, 13, 17, 18, 20, 22, 27, 30] Objections to training the undergraduate to treat the ''simpler cases'' of malocclusion are twofold: first, that he cannot obtain sufficient clinical experience from the present condensed curriculum; and, second, that recognition of the "simpler cases" requires a mature judgment. Higley[11] points out that this recognition of the ''simple case'' is a big order indeed, since it involves problems which frequently tax the orthodontists themselves.

It was these conflicting tenets that caused the Subcommittee on Teaching Orthodontics to poll the dental schools in the United States and Canada in an effort to determine the consensus of opinion regarding the teaching of undergraduate orthodontics.

The subcommittee summarized its findings at Chicago in June, 1949, with the following observations:[25]

1. The over-all orthodontic time is small when compared with other phases of clinical dentistry; therefore, it may be said that no school makes a serious effort to teach the theory and practice of orthodontics to undergraduates. Partial exception to this is Curriculum II of the University of California, where a limited number of "screened" students get "noteworthy" training.[10]

2. A great deal of the material presented in the orthodontic courses is basic to dentistry.

3. Almost all clinical courses are very limited.

In an effort to ascertain what changes, if any, had occurred since this survey was taken in 1948, I visited a number of dental schools during the summer of 1953. The most impressive finding of these visits was that, although seven schools claimed to have no laboratory (technique) course in the undergraduate orthodontic curriculum, according to the 1948 survey of the Subcommittee on Teaching Orthodontics of the American Association of Dental Schools, the likelihood exists that, even in these schools, this work is covered in the pedodontic department. I was able to find four schools which did not have a technique course in the summer of 1953 (although the University of Pennsylvania was planning one for the 1953-1954 year). In all four of these schools, comparable work was being done in pedodontics to give the student an acquaintance with the simple preventive appliances which are characteristic of the technique courses given by most of the dental schools.

In March, 1950, this subcommittee presented a program during its annual meeting at French Lick, Indiana. The objectives of this program were:[25]

1. To demonstrate the teaching of material that is fundamental to orthodontics and to indicate how this material is important to the concepts of general dentistry.

2. To present a suggested revised program of orthodontic teaching at the undergraduate level.

Only the first objective was carried out at this meeting, but it was one of considerable importance to the future of orthodontic teaching. A series of model lectures was presented under the guiding hand of Allan G. Brodie. They were:

1. Applications to Dental Anatomy.
2. Mechanisms of Adjustment to Wear and Accident.
3. Anatomical and Physical Principles.
4. Applications of Anatomical and Physiological Principles to Clinical Fields of Dentistry.
5. Growth of the Jaws and Eruption of the Teeth.

It is my opinion that this material could not only form a sound basis upon which to present an integrated dental-orthodontic concept to the undergraduate student, but could also provide a framework upon which to organize a postgraduate lecture series for the practicing dentist. It is in this latter field that the duty and interest of every orthodontist dictate that he give his wholehearted support.

The Committee on Education of the American Association of Orthodontists,[24] in its report at Louisville, Kentucky, in April, 1951, stated: "It is the considered opinion of this Committee that the expansion of clinical orthodontics provides an excellent opportunity to tie clinical dentistry more securely into its biologic background." The committee then recommended that orthodontics should occupy a definite position as a clinical department and that the objectives should be:

1. To anticipate and detect malocclusions.
2. To take steps to prevent or intercept malocclusions where possible.
3. To treat simple cases or the simple immediate problems of complex cases.
4. To use this knowledge as an adjunct to procedures in all other phases of dental practice.
5. To know what cases to avoid and refer to more experienced men.

Thus, we find that the objectives of the American Association of Dental Schools in 1950 and those of the American Association of Orthodontists in

1951 are now identical. This is indeed a happy circumstance when one considers the positions taken by these organizations some years earlier. Both agree that an addition of approximately 300 hours would be required to implement this clinical program. The Committee on Education of the American Association of Orthodontists further suggested that each school might do well to appoint a committee, with representatives from all departments, to determine content of such course or courses, its placement in the curriculum, and the personnel and facilities required for the presentation of this material. It also emphasizes the contention that "the total curriculum be revalued to make sure that it is consistent with sound teaching principles and efficient teaching methods and that it excludes repetitive, out-of-date, and other nonessential material."[24]

It is obvious that the greatest over-all need, from an orthodontic teaching standpoint, is to get the necessary time. This can be done only by streamlining the teaching methods and "tying in" the orthodontic concept more closely with dentistry as a whole. Efforts are being made to do just that. In one school, pedodontic patients are being assigned to the students as early as the freshman year. Each student follows his patients for the four years of his dental course. Thus, by being assigned patients of different age range, the student receives a cross section of a pedodontic practice, together with those problems of orthodontic implication which occur.[25]

At Indiana University, according to J. William Adams, the students "tie in" cephalometric x-ray films directly with the anatomy of the head and neck. This would certainly seem to be another evidence of the correlation of modern x-ray techniques with basic dental education. A number of schools visited placed emphasis on calling the preventive orthodontic procedures "pedodontics" rather than "orthodontics," thus making the student feel that it was definitely within his field, rather than in that of a specialty. In one school where removable space maintainers were taught, these were called "removable partial dentures," to promote the implication that these were definitely within the field of the general practitioner. Some schools visited (University of Kentucky, Ohio State University, and University of Pittsburgh) included labial arches, lingual arches, or multiple banded appliances in their technique courses. However, in the majority of schools, emphasis is placed on those appliances which prevent arch collapse or effect individual tooth movement. The most prominent over-all trend was that of attempting to establish a closer liaison between preventive orthodontics and pedodontics.

Generally speaking, the curricula of the majority of dental schools range between those which de-emphasize undergraduate orthodontic training (where instruction is limited to a lecture series which is integrated with pedodontics, as Temple University) and those schools where elective courses in clinical orthodontics are available (as Northwestern University and Tufts University). In this latter group of schools, cases are selected carefully and are confined to the "simpler type."

There are two schools whose curricula deviate considerably from the majority. They are the University of California and Harvard University. The

underlying teaching principle of these schools is to reduce the requirements to a concrete minimum and to permit the student to concentrate the remaining available time upon those phases of dentistry in which he is most interested.

At the University of California,[10] upon the completion of the first year of dentistry, the student may apply for one of three curricula. Curriculum I, the course which majors in restorative dentistry, is similar to the conventional course given by most dental schools. This course includes sixteen lecture hours of orthodontics. In Curriculum II, the student majors in preventive dentistry which stresses orthodontics and pedodontics. In Curriculum III, the student majors in teaching and research. Students are screened carefully for admission into the two latter groups.

In Curriculum II, orthodontics and related subjects are substituted for courses in prosthetic dentistry, although this curriculum does allot 208 hours of instruction to prosthetics. All other subjects, such as operative dentistry, exodontia, pathology, surgery, and dental medicine, are taught to students in all curricula. The students of Curriculum II receive over 1,000 hours of instruction in orthodontics, including over 700 hours of clinical work. Willard Fleming of the University of California feels that this plan merits the careful consideration of other universities.

At Harvard the method employed is different. Here the students spend the first two years with the medical students in the medical school. The philosophy is that this association will promote a feeling of equality between the dentist and the physician. At the beginning of the third year, the students report to the dental school for the first time. Here their actual introduction to dentistry begins. It is the contention of the faculty that these students are better grounded in the basic sciences and better "conditioned" to accept the responsibilities of outside work. Thus, it is contended that they are able to assimilate those dental courses which are found in the first two years of the conventional curricula in relatively short order. Here, too, the requirements are kept at a level which is considered to be an adequate minimum for all phases of dentistry, and the student is permitted to spend the remaining time in those phases of dentistry which interest him most.

It is interesting to note that all students actually carry orthodontic cases in the clinic. In the past three years (1950 to 1953), the number of cases varies from two to ten per student. Cases are selected which will require no more than one and one-half years of active treatment time, so that the students have the opportunity of carrying cases to completion. It should be mentioned that there are only fifteen students in each class at Harvard. These relatively small classes favor a flexible plan of this type. The faculty did feel that this method of teaching could be adapted to schools with larger classes, but admitted that it would require an increase in the size of the faculty in most instances.

THE VIEWPOINT OF THE DENTAL PRACTITIONER

The foregoing material has been concerned with the policies of teaching as interpreted by the administrators of dental schools, the orthodontic depart-

ments of the schools, the Committee on Teaching of the American Association of Dental Schools, and the representative group of the American Association of Orthodontists. How does the average general practitioner of dentistry feel about the admitted shortcomings of his dental-orthodontic education? The literature is singularly barren on this subject. It was felt that some small effort to elicit information along these lines might be informative.

Accordingly, a survey was considered which would attempt to determine the level of "orthodontic awareness and concern" of the general practitioner of dentistry. Since statistical material may be considered to be reasonably accurate only if the sampling represents 3 to 5 per cent of the population, it was decided to limit this study to the dental practitioners in the State of New York. To attempt a nationwide survey of this sort would require the resources of a major dental organization.

The technique of the survey, as suggested by members of the staffs of the School of Public Health, College of Physicians and Surgeons, Columbia University, and the Bureau of Dentistry, New York City Department of Health, was as follows: A list of general practitioners of New York State was prepared from the 1953 edition of the Dental directory of the American Dental Association. A name was selected at random from the approximate center of the list. Every twelfth dentist from that point to the end of the list, and thence to the beginning received a questionnaire. In all, 1,015 questionnaires were sent. The returns closely followed the prediction of the late Harry Strusser, Chief of the Bureau of Dentistry, New York City Health Department. Eighty-seven, or 8.6 per cent, were returned unanswered. Of the remaining 928 questionnaires, only 402, or 42.9 per cent, were returned properly completed. Of these returns, some of the individual answers were subject to question, and these answers were scrupulously discarded. Thus, the numerical answers to some of the questions do not total the total of returns.

It must be emphatically stated here that if the returns had approximated 100 per cent, these answers would have reflected only the opinions of the general practitioners of dentistry of the State of New York. There is no evidence upon which to assume that these opinions can be stated to be characteristic of the country as a whole.

An effort was made to discover whether any work had been done which compared the relative standards of New York State dentists with those of the country as a whole.

Samuel S. Herman, Chief of Resources Planning Branch, United States Public Health Service in Washington, D. C., suggested,* "I would urge caution in projecting your inferences from the New York sample to a nationwide basis. I would advise, for example, limiting the findings to urban northeastern States." Dr. Herman also mentioned the possibility of a "biased sample" which will be discussed later. He pointed out that the findings would be influenced largely by the school attended and the year of graduation. These latter factors were naturally considered, but it was the opinion of the statistical

*Personal communication, Oct. 6, 1953.

advisors that an "average or mean" attitude could be estimated only if the samplings were completely random in selection, as related to the dental school attended and the year of graduation. From the technique of sampling just outlined, this random nature of the sampling was maintained.

B. Duane Moen, Director of the Bureau of Economic Research of the American Dental Association, wrote,* "It would seem to me that the report of your survey should be written as a report on the general practitioners in New York State, with a statement to the effect that probably most of the conclusions apply fairly well to other states."

It must also be emphasized that 928 general dentists actually received these questionnaires, whereas only 402 replied. Thus, only 42.9 per cent of the dentists bothered to complete them. This, to a certain extent, affects the conclusions which may be drawn from the survey, since the 42.9 per cent who replied are probably the more interested in general. Thus, it might be concluded that these results are more favorable than those which would have been tabulated if all had replied. In view of this somewhat "biased sampling," it would be more accurate to assume that these answers might reflect the opinions of the "top" half of the general dental practitioners of New York State.

The results of the survey are as follows:

1. Do you know the approximate "average" age and sequence of the eruption of the teeth? Yes, 401 (99.7 per cent). No, 1 (0.3 per cent).

2. Do you believe that, in general, your ability to recognize incipient and existing malocclusions is good? 270 (67.2 per cent); fair? 127 (31.6 per cent); poor? 5 (1.2 per cent).

3. Do you know the difference between the Angle Class I, Class II, and Class III types of malocclusions? Yes, 290 (72.9 per cent). No, 108 (27.1 per cent).

4. Do you believe that child habits (thumbsucking, tongue thrust in swallowing, nail biting) have any effect on the occlusion of teeth? Yes, 377 (95.4 per cent). No, 18 (4.6 per cent).

5. Do you believe that, in general, space maintainers are advantageous in cases where deciduous teeth are lost early? Yes, 371 (92.5 per cent). No, 30 (7.5 per cent).

6. If you feel that space maintainers are advisable, do you:

Insert them yourself? 224 (62.0 per cent). Refer the patient to an orthodontist or pedodontist? 137 (38.0 per cent).

7. If one of your child patients (age 7 to 8 years) presents a lingually locked upper central incisor when the teeth are in occlusion, would you:

Treat this condition yourself? 172 (43.3 per cent). Refer him to an orthodontist or pedodontist? 215 (54.2 per cent). Do neither? 10 (2.5 per cent).

8. If one of your child patients (age 7 to 11 years) presents a unilateral or bilateral cross-bite of the first permanent molars, would you:

Treat this condition yourself? 41 (10.3 per cent). Refer him to an orthodontist or pedodontist? 322 (80.9 per cent). Do neither? 35 (8.8 per cent).

9. Have you, through the literature or any other source, been informed of results of studies in cephalometric radiography which relate to the growth and development of the head, face, and jaws? Yes, 148 (36.8 per cent). No, 254 (63.2 per cent).

10. Do you think that the orthodontic training which you received in dental school was adequate? Yes, 30 (7.6 per cent). No, 367 (92.4 per cent).

11. Have you taken a short course in either orthodontics for the general practitioner or pedodontics since your graduation from dental school? Yes, 121 (30.1 per cent). No, 281 (69.9 per cent).

*Personal communication, Oct. 7, 1953.

12. If your local dental society, in cooperation with your local orthodontists, were to present a series of six lectures or clinics, one night per week for six weeks, the purpose of which was a review on orthodontic recognition and a reminder of your responsibilities in the field of children's dentistry, would you attend? Since this questionnaire is going to some men in rural areas, we must assume that not more than one hour (round-trip) commuting time were involved. Yes, 299 (74.7 per cent). No, 92 (25.3 per cent).

Some of the figures follow that which might have been anticipated, but some are somewhat surprising. The answers to the first question were as expected, that the general dentist has a fairly accurate idea of the age and sequence of the eruption of the dentition. However, the fact that 99.7 per cent answered "yes" to this question leads one to suspect that either the dentist has a far better grasp of this aspect of children's dentistry than one might have assumed, or that he is unaware of his shortcomings.

The answers to questions 2 and 3 follow the expected. Sixty-seven and two-tenths per cent of the men feel that they can differentiate between the incipient or existing malocclusion and the normal, although 108, or 27.1 per cent, admit being unable to classify them roughly into groups according to the Angle classification.

The answers to question 4 indicate that the great majority (95.4 per cent) realize the effect of habits on the occlusion of teeth. The answers to question 5 were equally favorable, 92.5 per cent believe that, in general, space maintainers are of value where deciduous teeth are lost early. However, the answers to question 6 were both surprising and gratifying. Considerably more men who replied insert their own space maintainers than refer this work to specialists—62.0 per cent insert, as against 38.0 per cent who refer.

The treatment of anterior linguoversions (when seen early) is done considerably more frequently by the general dentist than was anticipated; 43.3 per cent of the dentists who answered attempt treatment when conditions are favorable, as against 54.2 per cent who refer these cases. Only 2.5 per cent permit the condition to go untreated.

However, molar cross-bites are considered differently by this group of New York State dentists. Only 10.3 per cent of the men claimed to attempt treatment here, while 80.9 per cent stated that they refer this work. However, 8.8 per cent of the answering dentists preferred to permit this condition to go untreated.

The answers to question 9 indicate clearly that we have not reached the dentist well enough with the "gospel" of cephalometrics. Only 36.8 per cent of the dentists stated that they had even heard of it. This would seem to indicate the need for more material on cephalometrics in relation to growth and development in the dental literature, rather than its being so largely confined to the orthodontic literature.

The answers to question 10 indicate beyond a doubt that the dentist is aware of the shortcomings of his orthodontic training at dental school—92.4 per cent thought it inadequate.

Furthermore, answers to questions 11 and 12 indicate clearly that he is interested in correcting this situation to the best of his ability. Almost one-

third of the dentists who replied (30.1 per cent) have actually taken a course in orthodontics for the general practitioner or pedodontics since graduation from dental school. Furthermore, question 12, which relates to a six-session lecture series, elicited a 74.7 per cent affirmative reply. Of those who replied "no," many noted that they were approaching retirement age. This would seem to indicate quite clearly that a great many dentists are definitely interested in overcoming some of their deficiencies in this phase of their dental education. It follows that there are tremendous possibilities for further education of the dental practitioner at the local society level, and the deduction is equally obvious that a great measure of this responsibility rests upon the qualified orthodontic specialist.

The survey questionnaire also requested additional remarks, and many men complied. Although the remarks were varied, they could be broken down into five major categories. First was the group that felt that the dentist should be trained to "handle simple cases." The second group felt equally strongly that the general practitioner should not attempt orthodontic treatment of any kind. It is interesting to note that the first group outnumbered the second group at a ratio of three to two. The third group of remarks centered about the problem of fees. Many men (especially those in the less urban communities) stated that the fees were simply beyond the means of many of their patients. The fourth group of comments elaborated on the shortcomings of the orthodontic course in dental school. The intensity of the remarks varied, but opinions expressed were consistent: that the courses received were inadequate. The fifth group of remarks centered about the lecture series proposed in question 12. These were overwhelmingly favorable (ratio of fifteen to one), although a number of men felt that a six-hour series was too short.

SUMMARY AND CONCLUSIONS

The development of undergraduate orthodontic teaching has been a slow process, but one in which the standards have been rising gradually over the past three decades. It is safe to say that the worst training given students today is better than the best that was given twenty years ago.[24]

A unanimity of aims and objectives is being achieved rather painstakingly in the minds of the leaders of those organizations most concerned with this phase of dental teaching. There are still some differences of opinion on how the present dental curricula can best be modified to accomplish the accepted objectives; but it is agreed that the underlying basic principles should be a streamlining of courses, elimination of repetitious material, and an emphasis on those aspects which are basic to both dental and orthodontic education. Teamwork by all departments of the dental school is of paramount importance.

There is a trend today for closer cooperation between the orthodontic and pedodontic departments of the dental schools, and further liaison between these departments is desirable if the present objectives are to be achieved.

Further clinical experience is mandatory if the undergraduate dental student is to be expected to accomplish even the most minor corrective procedures. Authorities agree that the addition of a minimum of 300 hours to the present orthodontic curricula would be required to achieve this goal.

Although the validity of the returns of the New York State dentist survey is subject to the question of "biased sampling," certain conclusions may be safely deduced. They are:

1. These dentists are aware of the deficiencies of their orthodontic education during dental school. Although about one-third claimed to have taken postgraduate courses designed to promote orthodontic awareness, a great deal remains to be done in this field. Emphasis should be placed on recognition of the "normal" occlusion, the anticipation and detection of malocclusion, and the interception of malocclusion, where possible.

2. The dental literature might well be augmented with more material concerning the growth and development of the head, face, and neck, especially as related to studies in cephalometric radiography.

3. The dentists seem overwhelmingly eager to remedy their present deficiencies in this phase of preventive dentistry. Wholehearted cooperation in this endeavor becomes the duty and concern of every practicing orthodontist.

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SPECULATIONS ON THE POTENTIALITIES OF CONNECTIVE TISSUE FIBERS

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INTRODUCTION

THE most important single structure to the orthodontist is the periodontal membrane. The infallibility of this statement is obvious, for without the structure tooth movement would be impossible. The present-day concept of this membrane, however, is comparable to that of the starter on our automobile. Without the starter we wouldn't go far; nevertheless, few of us inspect the starter when buying an automobile. It is the motor of the car that is the spectacular mechanism and that is what receives our attention. So it is with our current idea of the periodontal membrane. It is important only in so far as it is the activator of the bone change concurrent with tooth movement.

We will admit that this process (that is, the process of moving a tooth through bone) is the spectacular part of orthodontics. Were teeth held in position and supported strictly in soft tissues, the change in their position would be much more plausible (to the layman, anyway). But it is nothing short of miraculous the way the orthodontist can move teeth through solid bone. It is because of this magic which we perform that most attention has been directed toward bone changes in the repositioning of teeth.

Bone changes incident to orthodontic forces have been thoroughly analyzed in the past through the efforts of many of our greatest research workers. The changes in the connective tissue fibers, namely, the fibers of the periodontal membrane, gums, and the gingivae, have not been so extensively studied in respect to their response to tooth movement.

Clinical manifestations have brought us to theorizing and speculating as to what forces might be active within or about these fibers. We ponder the fate of the connective tissue fibers that are compressed, as well as that of the fibers that are stretched, when the teeth which they surround and to which they are attached are placed in new positions. Remembering the old law of physics, that for every action there is an opposite and equal reaction, we wonder if these fibers are capable of producing forces of reaction. If so, how could they be controlled? Should these fibers be considered in treatment procedures? The answers to these questions will doubtless come in the form of theory which, after all, is that which we have not yet learned to put into practice. I feel that examination into this field might lead us closer to the time when we will sub-

This thesis, which was given as a partial fulfillment of the requirements for certification by the American Board of Orthodontics, is being published with the consent and the recommendation of the Board, but it should be understood it does not necessarily represent nor express the opinion of the Board.

stantiate this theory with knowledge of exactly what is happening and how it can be controlled, to the ultimate glory and gratitude of the orthodontic profession.

So that we might have a common understanding as to what is meant by the connective tissue fibers in the title of this article, we would like to review definitions of the periodontal membrane, gums, and gingivae. The periodontal membrane has been defined[1] as: "The connective tissue which (1) fills the space between the surface of the root and the bony wall of its alveolus; (2) surrounds the root occlusally from the border of the alveolus; and (3) supports the gingivae." The second and third parts of this definition refer to the portions of the membrane that contain the connective tissue fibers with which we are concerned. The periodontal membrane does not stop at the border of the bone but continues to surround the root as far as the tissues are attached to it. It also extends into the free margin of the gum and is the means of its support, holding the gingivae close to the surface of the tooth and supporting them in the interproximal spaces.

The fibers of the periodontal membrane are distinguished from the gums, which are described as the soft tissues which cover the alveolar process and the hard palate, and from the gingivae, which are the continuation of the gum tissue from the crest of the alveolar process to the cervical portion of the tooth crown and include the septi which pass between the teeth.

The fibers of the periodontal membrane are distributed into the gingivae, the adjacent gum tissue, and the crest of the alveolar process and serve to bind the whole group into a compact mass about the neck of a tooth.[2]

After defining these fibers we should like to know of their functions. Most texts list three functions of the periodontal membrane: (1) a physical function, (2) a vital function, and (3) a sensory function. The physical function is manifest in the maintenance of the tooth in relation to the adjacent hard and soft tissues. This function of the periodontal membrane has two roles. It supports the tooth in its alveolus and sustains it against the forces of occlusion and mastication by its attachment to the bone, to the gum tissue to the occlusal of the bone, and to the cementum of the adjacent tooth. It also maintains the soft, investing tissues in their proper relation to the teeth by giving support to the gingivae and holding them about the gingival portion of the enamel.

The vital function is that of formation of bone on the alveolar wall and of cementum on the surface of the root.

The sensory function is that of the sensation of touch for the tooth.

In addition to protection, one of the important functions of the gingivae always listed is that *they maintain the teeth in the line of the arch.* Black[2] describes this function well when he states:

> The influence of the bone forming the alveolar process has been much overrated in its importance in maintaining the teeth in their positions. Hard and rigid as the bones of the skeleton seem in the dried state, bone is a very plastic tissue during life, and is subject to more or less constant resorptive and rebuilding processes. It will not stand against a connective tissue constancy of stress. The connective tissue group, other than active muscles, has a great function in directing the building of the body, holding organs in their places in

health, and bringing them back to place when the correction of conditions will allow them freedom of action. . . . There is no place in the human body where there are as fine examples of this play at control of form by the non-muscular connective tissue as in the gingivae, or so much harm from its influence when the conditions have given them a wrong direction.

The function of these fibers is not to create a good alignment of the teeth, but rather, after they are in the line of the arch, to maintain them there. Now, if the teeth are placed in malalignment, does this same function persist? Would not the same forces that maintain teeth in the line of the arch be working if those teeth were not perfectly aligned? If the maintenance of teeth in their erupted position is one of the functions of these fibers, then orthodontists must overcome that function in their repositioning of teeth.

The chief function of the gums is said to be protection of the underlying tissues; however, with the connected fibers interweaving with those of the gingivae, undoubtedly the function of the gingivae is shared to some extent by the gums.

REVIEW OF LITERATURE

Briefly, let us review a few of the findings of men who have observed these connective tissue fibers and their actions. Particularly pertinent to this subject is the work of Erikson, Kaplan, and Aisenberg, who reported on "Orthodontics and Transseptal Fibers."[3] These men removed a tooth in both a female and a male adult and approximated the adjoining teeth over a period of thirteen months. These were held for eleven months and five months, respectively. Their histologic sections of these areas showed remarkable persistence of the transseptal fibers. In the extraction area the transseptal fibers remaining in the interdental papillae fused with the connective tissue over the extraction wound to form a new, but elongated, group of transseptal fibers. These fibers, after the teeth were approximated, had become compressed and caused crushing injuries to the periodontal membrane and alveolar bone. Even after almost a year of mechanical retention, this excess of tissue fibers had not been removed, and they concluded that there seemed to be no process which shortened these fibers or removed them.

Chase and Revesz[4] removed second deciduous molars in monkeys and moved the adjoining teeth into the area. They concluded that there was a regeneration of fibers strongly resembling transseptal fibers and that this reorganization took place in orderly arrangement in spite of the orthodontic forces.

Stuteville[5] concluded that injuries to the periodontal membrane in tooth movement were more theoretical than real.

Breitner[6] believed that tissue changes in orthodontic treatment concerned chiefly the hard tissues because they were much more easily influenced than were soft tissues.

Aisenberg[7] divided the periodontal membrane fibers, from a practical viewpoint, into two groups: one attached tooth-to-bone and the other attached tooth-to-tooth or tooth-to-subepithelial connective tissue. He wrote that the arrangement and attachment of the former group, when including changes

in bone, may be altered, but that "we are not so certain about being able to alter the latter group. The subepithelial tissues do not conform to tooth movement as does bone; hence this may be a factor in relapse."

It was the opinion of Oppenheim[8] that "the powerful fibers stretching across the septa, giving off strong bundles to these and partly to the gums, prove to be the most resistive tissue with which we are dealing in our operations." He also noted[9] that it was during the period of bone change following the cessation of force on a tooth that "relapse following orthodontic tooth movement," or free movement of teeth toward their original position, took place.

We would conclude from the findings of these men that the regenerative or reparative qualities of these supra-alveolar connective tissue fibers are great; that they are very resistant; that we have little or no control over them; and that they may be a factor in relapse.

The reactions of connective tissue fibers have been described by most authors as incidental to the bone changes. Their disposition is handled by and large with the suggestion that the fibers are simply reorganized and reattached to meet demand. We wonder if this process has not been oversimplified.

These fibers may appear as small, insignificant bystanders in tooth movements, but in actuality they may be tiny but mighty, acting slowly but definitely in foiling some of our beautiful orthodontic results. They are tough. They are resistant. They could be culprits.

DISCUSSION

The first suspicion that connective tissue fibers might be influencing our operations came with the observation of the frequency of relapse in rotations. There simply was no explanation of this reversion, especially in some cases where theories of habits, basal bone, muscle balance, growth, heredity, malfunction, overexpansion, etc., could be ruled out. The force that would return a tooth to its previous malrotation after treatment and retention was a powerful one, and it had to be intrinsic with the tooth or within the area surrounding the immediate environment of the tooth. This deduction led to scrutiny of the structure and arrangement of the fibers surrounding and attached to the teeth, with the hope that this might earmark some of our difficulties.

It has been pointed out that the fibers of the periodontal membrane, gums, and gingivae are inelastic and that they do not travel in a straight line. They have been described as wavy in appearance. This is the characteristic that permits the slight movement of the tooth in its socket. The degree of this waviness has not been described, but it has been shown histologically that some of these fibers are capable of extensive elongation simply by straightening out this waviness.[10] Along with this sinuous effect of the fibers, there undoubtedly is intermingling and weaving in, around, and about themselves, and surrounding vessels probably add further to their irregular course. Such an arrangement of the individual fibers would produce an image not too different from that of the familiar coil spring.

Wire, that with which we move teeth all the time, is also a nonelastic material. It does not move teeth by virtue of its elasticity, but when contoured in certain fashions it delivers very effective forces. The coil spring is today one of our most efficient devices for obtaining tooth movement. If we could imagine, then, that in the inelastic connective tissue fibers surrounding the tooth we have numerous coil springs both pulling and pushing, we could arrive at some conception of what forces might be activated within them when a tooth is moved.

Let us consider the action of these coil springlike fibers, both attached and unattached to bone. It is generally known that compression of fibers of the periodontal membrane attached in bone results in bone resorption; and that, when put under tension, these fibers produce bone building. The fibers are the catalyzer, so to speak. They do not enter into the reaction themselves, but the reaction is produced by their presence. Contrary to what might be expected, bone tissue is more plastic or pliable than the connective tissue fibers.

If these forces of compression and stretching are found in the fibers which are not attached to bone, the compensating plasticity of surrounding tissue does not prevail. The supra-alveolar fibers, including some fibers which are attached to cementum and others which are attached to other fibrous networks, comprise the group that requires special attention. Clinically or histologically, no spectacular changes might be noted when these fibers were put under tension or pressure. There is little confinement of these supra-alveolar fibers and their compression probably would bring about merely a slight swelling of the tissue. On the other hand, stretching of the fibers would likely produce only a thinning of the tissue. Neither of these symptoms might be profoundly noticeable, yet they could be persistent enough to initiate forces effecting tooth movement. The beautiful picture of resorption on one side and building on the other side has not been shown for the soft tissues effected in tooth movement.

Since the cementum and other connective tissue networks to which these supra-alveolar fibers are attached are more resistant to both tension and pressure than is bone, the compensating mechanism which permits tooth movement in bone does not transpire effectively in this area. Some of these stresses and strains produced in this area may be stored. They may exert their great function of "bringing them (the teeth) back to place when the correction of conditions will allow them freedom of action."[2]

In all areas of the denture, except the molar areas, the mesial and distal surfaces of the teeth, to which the so-called transseptal fibers are attached, are broader surfaces than the labial, buccal, or lingual. Too, there is a convexity of the cementoenamel junction toward the incisal surface of the anterior teeth, which provides a greater area for the insertion of these fibers. These larger surfaces permit the fibers a stronger grip on the tooth. This particular group of fibers connecting the teeth always consists of a large number of strong fibers.[2]

The gingival group of fibers of the periodontal membrane encircles the tooth completely. They are much thicker and stronger on the labial or buccal and lingual surfaces than on the proximal surfaces.[2] Thus, we have powerful fibers of the periodontal membrane completely surrounding each tooth anchored

by other fibers from one tooth to another. There is a possibility that these groups of fibers, when stretched or compressed, might be influential in our attempts at tooth rotation or any tooth movement, and the permanence of such a movement.

In applying this theory to rotations, for example, imagine a lower left lateral incisor that was rotated mesiolingually and brought around to its correct position. The fibers on all four sides of the tooth would be altered. We are thinking specifically of the supra-alveolar fibers. Those on the mesiolabial side would be compressed and those on the mesiolingual would be stretched, while those on the distolabial would be stretched and those on the distolingual would be compressed. Just where the dividing line on the labial and lingual between these forces would be is hard to determine. Since we are theorizing, we might presume that for every compression of the fibers on the lingual, there would be a stretching on the labial, and vice versa. The forces activated on the mesial and distal sides of the rotated tooth would likewise be found on the proximating teeth. However, where these stresses and strains are on all sides of the rotated tooth they are active only on one side of the proximating teeth and the fibers attached to the other three sides could conceivably counteract these forces. The rotated tooth in its new position has, in effect, many push-and-pull coil springs working on it and, with the evident persistence of the fibers, these forces may be potential for a long interval of time. The undisturbed fibers on the three sides of the proximating teeth could counteract the disturbed fibers on the one side, and thus the tooth that had disturbed fibers on all sides would be the tooth to be effected if this arrangement persisted when mechanical interference was removed. This might offer some explanation of why it is always the same tooth that was rotated previously that reverts.

The potentialities of these fibers and their presumed effect upon rotated teeth then led to observations in other instances, where the forces at work might be accounted to the connective tissue fibers. The familiar spacing of the incisors that accompanies the distal movement of cuspids where premolars have been removed immediately comes to mind. Almost universally, credit has been given the transseptal fibers for this spacing. The fibers connecting the cuspid with the lateral incisor exert distal pulling force on the lateral incisor and the distal movement of the lateral incisor, being attached to the central incisor by connective tissue fibers, in turn exerts a distal tension on the central incisor. This spacing occurs even when the incisors are banded and an arch wire is ligated to them, indicating the intensity of their strength. It has been found that these fibers are seldom torn or broken under tension.[10] The connective tissue fibers of the periodontal membrane are not as easily injured under tension as under pressure.[11]

In the area of the extracted premolar, where there has been approximation of the adjoining teeth, compression of the fibers results. The histologic evidence for this has been pointed out previously[3] and was confirmed by Thompson.[12] The clinical evidence of this compression is found in the groove, or indentation fold of tissue, on the buccal and lingual surfaces of the interdental area between the approximated teeth, as well as in the frequent reopening of

this contact. If connective tissue fibers affect tooth movement in this particular operation, would it not be logical, then, to assume that they are a factor in other procedures?

Arnim and Hagerman[13] made a study of horizontal serial sections of human, monkey, and rat jaws, which revealed a band of compact connective tissue encircling the teeth within the marginal gingivae. Not only are teeth surrounded by the gingival group of fibers of the periodontal membrane and bound together by a fibrous band from tooth to tooth in the transseptal groups, but they are also encircled with a separate but similar band. Also, the connective tissue fibers pass across between the adjoining teeth, through each interproximal space (gingivae), and unite the soft tissues covering the buccal and labial parts with the lingual parts, thus anchoring each tooth even more securely. With the interweaving of all this compact mass of fibers around the neck of a tooth, it could be presumed that Nature has provided a very stable linkage of the dental units in an arch. If the teeth of a dental arch are bound together from last molar to last molar by such a tremendously strong tendinous-like fibrous connective tissue, it may furnish more of a potential obstacle to the orthodontist than has been realized.

Reflection on the potentialities of this fibrous union of the teeth in an arch is enlightening. A study of the potential effects of the connective tissue band on various tooth movements makes for interesting contemplations. Consider, for instance, the fibers that would be disturbed when a tooth that was lingual to the line of the arch was put in alignment. The fibers immediately attached and surrounding the lingually placed tooth have as their function the maintenance of that tooth in that position. Again, we are considering those fibers not attached in bone. The forces that are inherent in the fibers in the performance of their function would have to be overwhelmed. But, in addition to these fibers, there are those which are attached from the tooth to the distal of the malpositioned tooth to the tooth to the mesial of the malpositioned tooth. These fibers are in the line of the arch and occupy the position which the lingually placed tooth would occupy in its new position. Usually space has to be made for such a lingually placed tooth before it can be moved labially. The creation of this space stretches the fibers in the line of the arch to some extent, and then the labial movement of the lingually positioned tooth stretches or elongates them still further. A knowledge of the power and resistance of these fibers makes it easy to comprehend why there might be a tendency for the corrected tooth to return to the position from which it came.

The same type of stresses on the connective tissue fibers would be found where a tooth was labially or buccally placed and subsequently moved lingually. These movements, both labial or buccal and lingual, would be influenced by more fibers than a tooth movement in the line of the arch. Hence, we would suspect that treatment procedures involving changes in position of teeth in the line of the arch might be easier to accomplish and might offer more stability of results.

In depressing and elongating movements these same fibers could logically be the counteracting forces. Oppenheim[8] has observed that with depressing

forces the fibers at the occlusal border of the alveolar process, those attached tooth-to-tooth and those constituting the so-called ligamentum circulare, were still intact and resisted the depressing force. If these fibers could be stretched in producing such tooth movements there might be a tendency for them to seek their original level again when let free.

We might mention that in tooth eruption connective tissue fibers play an important part. According to Weinmann and Sicher,[14] in *Bone and Bones:* "It is the proliferation of the pulpal connective tissue which generates the slight pressure necessary for the movement (tooth eruption). This pressure is directed toward the surface of the jaws by the presence of a ligament upon which the growing end of the root rests." (This is a connective tissue fibrous ligament.) "The ligament protects the bone in the fundus of the crypt from resorption resulting from the pressure of the growing root and permits movement of the tooth only toward the surface of the jaw instead of the growth of the root into the jaw itself."

This supplies further evidence of the strength and resistance of connective tissue fibers, and affords us the hint that we should be more concerned with the management of soft tissues in our procedures.

Still another possibility of the influence of connective tissue fibers on orthodontic practices is their role in expansion therapy cases. Any orthodontist who has tried to correct the buccal cross-bite of a cleft palate mouth knows of the difficulty of the procedure and, perhaps, may have observed the stretching of the tissue, sometimes even to the point of reopening the repair. Still, on occasion, buccal cross-bites with a normal palate may be difficult to retain. The stretching of the palatal fibers which occurs with the buccal movement might be a possible explanation. Most expansion treatment is performed with the idea of gaining more space for the better alignment of teeth. In other words, the arch length under such treatment is to be increased. The work of Hays Nance[15] is pertinent here. The arch can be lengthened but, when out of retention, there is a tendency for return to its original length. Recall the fibrous mass uniting the teeth around the arch. If this fibrous band is a given length and it is stretched, its power to return to its original length might explain the failure of some expansions. The same connective tissue band of fibers might play a role in Strang's[16] axiom of mandibular canine width. In re-emphasis: the length of the band or network of connective tissue fibers which links all the teeth of a dental arch together as a unit could conceivably limit the extension of arch length. This confining, or limiting, fibrous band theory would be concomitant, then, with the basal bone and muscle balance theories. It has been shown that connective tissue fibers withstand tension forces with more vigor than compression forces. This might be the reason for greater success in treatment which shortens arch length than in procedures where attempts are made to lengthen it.

Further evidence of the power of connective tissue fibers to move teeth is found in the diastema or migration of teeth in periodontal disease. The atrophy of the interdental papilla in the vertical type of periodontal disturbance

eliminates the fibers which have as their function the maintenance of the tooth in the line of the arch. An early characteristic clinical symptom of this type of disease is the separation of teeth.[17] A good conjecture is that the fibers (supra-alveolar) hold one group against another in maintaining the teeth in their proper positions and that, under normal conditions, the inherent forces of the various fibers are accurately balanced. At any rate, with the destruction of the interdental fibers, the teeth are moved away from the injured area, which would indicate some sort of a tonicity or balance between the fibers.

Hypertrophic gingivitis is characterized by separation and protrusion of the teeth.[17] Diffuse fibromatosis of the gingivae causes frequent distortion of the position of the teeth.[17]

Finally, evidence of the power of connective tissue fibers to move teeth is suspected when a full-banded appliance is removed and no retainers are inserted. Immediately the interproximal spacing created by the bands is closed where the teeth were in contact previous to treatment. Where spacing existed previous to treatment there is a tendency to opening of contacts.

In the light of these evidences, I believe we could surmise that connective tissue fibers are capable of moving teeth and that they do play an important role in maintaining the teeth in their erupted position. With one of their functions, that of withstanding the forces of mastication, it would surely be agreed that they can withstand terrific forces. They can give or take. They are persistent and very resistant. They offer the orthodontist a distinct challenge.

The profession has met this challenge to date by trying to outlast and outguess these fibers. Some attempt to overcome the forces of these fibers has been made in the overcorrection of rotations. This was done, perhaps unknowingly, on the theory that overstretching these fibers would weaken their power of return. It is purely guesswork as to how much to overrotate, and always after this is done there is a silent prayer that the tooth will revert, but that it will revert only the correct amount. Overcorrection in all tooth movements is not practical. Again, in the retention of cases, it is a guess as to when these fibers have given up and when the patient can be told to discard the retainers. It then behooves us to search for some method of neutralizing these forces and overcoming the guesswork.

Some efforts have been aimed at this in the past. Skogsberg[18] performed septotomies to insure stability of his cases. He may have been getting pretty close to the answer. He was not performing these operations with the idea of neutralizing forces within the soft tissue, but rather of neutralizing what he felt was the elasticity of the bone.[19] He gave evidence of his theory in a large number of clinical cases reported with pictures of casts. His cases were those with rotations, diastemas, and lingually and labially malpositioned teeth—cases difficult in retention. With his septotomy, the stability of the results was improved. Perhaps he did neutralize some fibers within the bone but, probably more important, he neutralized other connective tissue fibers with the incisions on both the labial or buccal and lingual sides.

In the handling of these fibers it may be necessary to use methods that are severe. We are dealing with tough, resistant, persistent tissue, even though

it is small in quantity. It would seem that where we have evidence that tissue fibers are under tension, we might sever the fibers and permit healing without tension. Where there is evidence of compression of the tissue, we might remove some of it.

To some, this procedure may seem radical and injurious, but who is there to say that all of orthodontics is not injurious? The whole process of tooth movement is a continual cycle of damage and repair, as there is no appliance capable of physiologic forces. Would it, then, be too great a price to pay for stability of our cases to resort to some type of operative procedure on the connective tissue fibers surrounding the teeth? A gingivectomy performed in a diseased mouth is not considered too injurious for that which is gained. The reparative qualities of the gingivae and the periodontal membrane are well known. With care there can be little damage that is of a permanent nature in such procedure.

Just what technique may prove to be most satisfactory in the control of these fiber forces is questionable. Some of the techniques that need further clinical experiment might include some sort of surgery of the connective tissues surrounding the necks of the teeth. The more recently developed electrosurgical scalpels, or electric knives, or electric cautery might prove to be the better means of neutralizing these fibers.

Electrocoagulation might prove the method of choice.

In this atomic age it might be that the use of some radioactive substance would supply the answer to our problem. Radiation therapy might be a possibility.

Some agent might be found which, upon injection, would halt the harmful action of these fibers. Although techniques have not been refined, injections have been made which produce a necrosis of the underlying connective tissue and at the same time leave the epithelium intact and healthy. If such injections could be controlled to act upon limited areas they might prove ideal for regulating pressures and tensions of the connective tissue fibers we wish to control.

Many questions have to be answered before any method can be advocated. We need to know more about the healing factors of connective tissue fibers, especially where they are under stresses and strains. We need to know whether healing would produce still other forces. This might be suspected from the clinical observation that teeth approximating a space where a tooth has been removed tend to be pulled into this space. We need to know how thorough the inactivation of these fibers would need be to produce stability. We need to know more of the genetic tendencies of these fibers. We need to know whether it would be better to interfere with these fibers before our orthodontic procedures or upon completion of treatment.

The answers to these unknown quantities, however, can be found. If our profession will but recognize that there are long-enduring forces at play when these connective tissue fibers are disturbed, it will be only a matter of time until the method of overcoming them will evolve.

The time since the advent of the idea of neutralizing the inherent forces of the connective tissue fibers has been too short to accumulate sufficient clinical evidence to give support to these speculations. Through the media of the scalpel and electrocautery, however, some attempts have been made to neutralize the forces that were suspected. Time will tell of their merit. It is hoped that further experimentation in this challenging field will produce results of value.

SUMMARY

The connective tissue fibers with which we are concerned in orthodontic tooth movement have been defined, and their functions have been described.

The histologic findings of prominent research workers, showing that these fibers were persistent and resistant to control, were reviewed.

Clinical observations were recalled to indicate evidence of the force of these fibers, and the possibilities of their effect upon tooth repositioning were noted.

The confining, or limiting, connective tissue fibrous band theory was proposed as a supplement to the basal bone and muscle balance theories. Explanations of relapse were described in the light of the potential persistence of this connective tissue band around the necks of the teeth.

It was pointed out that the connective tissue fibers must be capable of tooth movement and that they might restrain other movements.

It was suggested that, theoretically, these forces might be neutralized by various methods, but no specific method was advocated.

CONCLUSIONS

The review of the potentialities of the connective tissue fibers has not been presented with the thought that this is the utopia—that, once the forces involved are controlled, all tooth movements will be stable. We believe that a case still will have to be thoroughly analyzed with all the care and study of modern orthodontic procedures. With control of these potential forces, however, tooth movements may not be so restricted. That is to say, with a knowledge of how to handle these forces, there might be a possibility of greater freedom in treatment planning. Such control might shorten the duration of treatment procedures. There might be more assurance of the permanency of our efforts. Certainly, after a case has been treated and is ready for retention, attention should be directed toward these fibers and their potential forces.

We sincerely believe that the inherent forces of these fibers do exert an influence on our results, and that the time will soon come when we can say that we have mastered these forces.

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6314 BROOKSIDE PLAZA.

Editorial

Clinton Chappel Howard
1884-1955

C. C. HOWARD, pioneer orthodontist in the southeastern part of the United States, died on July 23, 1955, at the age of 71 years, in a Miami, Florida, hospital. Dr. Howard's death calls to mind an important orthodontic era and reflects some original research work that is now all but forgotten.

Probably the most important contribution that he made was the correlation of what is known in medical literature as the Howard syndrome. Dr. Howard was the first orthodontist to work in an all-medical clinic. Little was known about the subject of the relation of malocclusion to endocrinology before Howard, Elkins, and Englebach started their work. Perhaps about all that was known was that occasionally the comment was heard that "flatfeet and malocclusion of teeth may have the same origin." In so far as it is possible to ascertain, the Howard syndrome is the first well-defined classical physical picture that was recognized within the ranks of the dental profession and quickly taken up and recorded in the literature of scientific medicine as a syndrome of importance. Howard contended that malocclusion of the teeth does not begin with the teeth and jawbones and end there, as some of the literature would indicate. His was a restless mind, interested in zoological and biologic things; he had a love of Nature and all living things. He was critical of some of the basic concepts of orthodontics, in that he felt that much of the biologic nature of the subject was being ignored in favor of the mechanical department.

Dr. J. K. Fancher, medical director of the Good Samaritan Clinic in Atlanta, Georgia, had the following to say about the Howard contribution when the *American Journal of Orthodontics* wrote to him for his opinion: "Dr. Howard was a member of the staff of the Good Samaritan Clinic for endocrine research for eighteen years. During that time he made various notable contributions of a scientific nature based upon observations made at the Clinic.

"We feel that the honor being paid him in having a syndrome named for him is only his just desert for his noteworthy achievements. It is our hope that the trail he has blazed will become a broad highway because of further investigations showing the connection of hormonal action and orthodontic difficulties.

"We are proud of Dr. Howard and his work here and congratulate him."

Interesting in retrospect are some of his views, gleaned from his published papers. He did not think much of the routine orthodontic diagnosis by ob-

serving the relative position of the upper first molar to the lower first molar, or the canine eminence to the orbital plane. He felt that this had little to do with the problem at hand.

He worked with medical men in the Good Samaritan Clinic in Atlanta, Georgia, where they studied the entire individual in all physical phases and tried to coordinate the entire physical picture of the whole body. Out of this experience came fifteen papers by Dr. Howard, most of which have been formally recorded in either medical or dental literature. He coined the term *acromegaloid growth,* and that term obviously came about as a result of his observation that there is a classical type of person with an obtuse, bulky mandible, the type well known in the Angle classification as Class III. According to Howard, but

Clinton Chappel Howard

few of these cases are of local origin or are true, actual acromegaly, as described and identified years ago by the Frenchman, Marie. Dr. Howard reported that there is much more to this over-all syndrome of Class III occlusion than the local maxillary dental concept described by Angle, Kingsley, Case, and others in their writings. Howard reported a combination of symptoms common to many of these cases and pointed out that the bulky mandible is only one. Another symptom is early puberty and it was found, by checking with thousands of x-ray pictures of the hands, that the epiphyses unite with the parent bones at

a very early age. By checking hundreds of clinical records, it was ascertained that the perverted mandibular growth checked side by side with still other symptoms that were too obvious to ignore. Such is a thumbnail sketch of the Howard syndrome that attracted wide attention in medical literature some years ago.

The story of the typical acromegalics dates back many years in scientific literature; however, the acromegaloid (meaning "like acromegaly") growth picture in orthodontics was correlated first by Howard. Out of this came the observation credited to him on the subject of orthodontic diagnosis, namely, that "the first and most important information necessary for a sensible orthodontic diagnosis is the general visual survey of the child as an entire physical individual." The Howard syndrome, he said, is characterized by certain physical markings: a lower jaw that protrudes, a long obtuse angle formed by the ramus, and a horseshoe body that is decidedly obtuse. The epiphyses become a unit of their parent bones at an unusually early age. (The buttons and the long bones grow together years before the average.) The typical individual has a high intelligence quotient. Pubic, axillary, and body hair incident to pubescence appears at an early chronologic age. Howard was the first to point out that stimulation through orthodontic appliances alone has little permanent and lasting effect in classical orthodontic cases commensurate with the effort expended. He further claimed, in this connection, that the impulse of the hormone is entirely too persistent to be permanently influenced by the impetus of delicate mechanical devices.

There can be little doubt that the Howard contribution to orthodontics attracted more attention in the medical profession than any other contribution since the birth of orthodontics, and the syndrome was well recorded in both medical and dental literature.

Dr. Howard's work at the Good Samaritan Clinic was never followed through after his retirement from orthodontic practice (rather early in his career).

Another orthodontist with a research background, who was in complete sympathy and accord with Howard's work, is Dr. A. Leroy Johnson, a former member of the faculties of the University of Michigan and the University of Pennsylvania. Dr. Johnson, too, retired at about the same time and identified himself with the Markley Foundation and with the committee directing the Charles R. Stockard research on the genetic and endocrinic basis for differences in form and behavior as elucidated by studies of contrasted dog breeds and their hybrids, according to methods of the Department of Anatomy of Cornell University Medical College.

Dr. Howard took great interest in the Stockard experiment because it proposed to go into this subject of endocrinology in a much more comprehensive way. Unfortunately, the Stockard work was left unfinished because of the death of Dr. Stockard. There are many orthodontists who feel that the Howard work was important but remains incomplete, largely for the reason that, as the work was independently sponsored, there was no replacement able to carry on after his retirement. A Ketcham Award winner, Dr. Howard made an important

impact upon the over-all thinking with regard to orthodontic diagnosis, and it is to be hoped that his work will be picked up where he bowed out about sixteen years ago.

In recognition of his contributions, the Fifth District Dental Society of Atlanta bestowed upon him the first life membership ever presented by that society. In addition to that, he was presented with a gold membership card, and on it was engraved the appropriate words "in appreciation for his great efforts directed to the advancement of dentistry."

Dr. Howard was a founder and first president of the Southern Association of Orthodontists. He worked for the establishment of free dental examinations for Atlanta school children and was instrumental in the formation of the Council of Dental Education of the American Dental Association.

He lived and practiced in Atlanta for years before he retired in 1942. He was born in Selma, Alabama, and received his A.B. degree from Birmingham-Southern College. He also held the D.D.S. degree from the Dental College of Southern California.

Dr. Howard first practiced dentistry in Huntsville, Alabama. After his retirement he lived in Charleston, South Carolina, Miami, and on the Isle Marada in the Florida Keys.

He served as president of the American Association of Orthodontics, the Georgia Dental Association, and the Fifth District Dental Society. In 1948 the Ketcham Award of the American Board of Orthodontists was awarded to Dr. Howard.

He was a member of the Piedmont Driving Club and the Capital City Club while he lived in Atlanta.

He was graduated in 1911 from the Angle School of Orthodontia at New London, Connecticut. He was one of the original group to work with the pin tube appliance and probably the first to abandon it.

Dr. Howard practically made an avocation out of hunting and fishing and was regarded as a serious student of wildlife. He gathered together and sponsored the wild-life exhibit of the State of Georgia at the World's Fair in Chicago.

The latter years of Dr. Howard's life were spent on the Florida Keys, where he spent most of his time out-of-doors, many times with his friend, Dr. Lunsford. Dr. Howard was a charter member of the forty-four-year-old Atlanta Mid-Winter Clinic, which was later changed to the Thomas P. Hinman Mid-Winter Clinic, and for a period of ten years he was chairman of this clinic.

No name in orthodontics ever became as well known in the medical profession as that of C. C. Howard. Orthodontics has lost one of its colorful and personable pioneers. Even though much of his unfinished work is recorded in both medical and dental literature, much of it has dimmed with time. It is hoped that some research group in either the medical or dental profession will pick up the threads where C. C. Howard left the scene.

His survivors include his daughter, Mrs. Anthony J. Drexel, III, of Nassau, Bahamas; two brothers, Dr. Leon Howard of Denver, Colorado, and another of Alabama; and three grandchildren, who live in the Bahamas.

H. C. P.

Reports

REPORT OF THE HISTORIAN TO THE BOARD OF DIRECTORS OF THE AMERICAN ASSOCIATION OF ORTHODONTISTS

YOUR historian was nominated at the 1954 meeting in Chicago and is to be voted on at the meeting in San Francisco, California. He is functioning this year ad interim by appointment of President West, who was authorized to make the appointment. It is his understanding that it shall be his duty to collect all pertinent data of an historical nature pertaining to the Association. His report shall be presented to the Board of Directors annually and, upon its approval, shall be sent to the librarian for safekeeping in the official repository of the Association.

At the Golden Anniversary Meeting, held in Louisville, Kentucky, in April, 1951, a history of the first half-century of this Association was presented, adopted, and published. Its compilation was a strenuous task, as historic data had not been kept. With the establishment of the office of historian, the compilation of the second half-century should be comparatively easy.

There have been two meetings held since the publication of our history—the first held in Dallas, Texas, in 1953, with Brooks Bell as president, and the second in Chicago, Illinois, in 1954, with James W. Ford as present. A questionnaire, similar to the one previously used, was mailed to each. These were promptly returned and have been prepared for filing in the Association's archives. Each one contains the respective president's personal comments evaluating the outstanding contributions and events of his meeting.

A photographic collection of the past presidents was made for the first historic volume. This met with much enthusiastic approval. It is recommended that this be continued. To this end, the past presidents were asked for the loan of their favorite portrait, from which a 3¼ by 4¼ inch negative was made and the photo returned. From the negative, a lantern slide of standard 3¼ by 4 inch size and a glossy print were made. These will be systematically filed and will become a part of the historic archives.

The historian has such records of most of the presidents of the first half-century. To save expense in preparation at the time, he used some material that he had previously prepared for an historical review of the first twenty years of the Northeastern Society of Orthodontists in 1941. This saved duplication of lantern slides, etc., of eleven past presidents, namely, J. Lowe Young, Herbert Pullen, John V. Mershon, Frank Delabarre, Charles Hawley, William Fisher, Harry Kelsey, Alfred P. Rogers, Lowrie J. Porter, Joseph D. Eby, and L. M. Waugh. These slides were then returned to the files of the Northeastern

Society. The photographic material of all other past presidents is on hand and will be sent to the librarian as soon as the repository of the Association becomes available.

The cost of producing such records as advised is as follows: negative of portrait, $1.00; glossy print, $.15; lantern slide, $.60; hand retouching of lantern slide, $2.00; this makes a total of $3.75 for each president. To date, there are thirteen to be completed with one more, President West, to be processed during the coming year. If the Board decides to approve the recommended procedure, the cost would be $52.50. Hereafter, the cost for each retiring president would be $3.75.

There will be some little expense for mimeographing of questionnaires, postage, etc. Therefore, a budget of $60.00 might be provided for this year.

For the following years, one of $15.00 might be ample.

The historian would urge each director to make suggestions for improvement in the format used in the history published. It is his desire to file records that will be of the most help to the one whose work it will be to prepare a second volume fifty years hence.

Respectfully submitted,
L. M. Waugh, Historian.

REPORT OF THE NECROLOGY COMMITTEE OF THE AMERICAN ASSOCIATION OF ORTHODONTISTS

Booklet.—On Oct. 12, 1954, in accordance with the request of the Board of Directors, two copies of the booklet prepared by a previous Necrology Committee of the A.A.O. were sent to the Secretary of the American Dental Association, with the suggestion that they might be of interest to the membership. An acknowledgment indicated that this matter would receive the attention of the Board of Trustees of the A.D.A. at the Miami meeting.

On Feb. 22, 1955, I wrote the Secretary of the A.D.A. and received the reply that he will advise us if any action is taken and, further, that it is likely, since these are pamphlets of another organization, that the Board of Trustees will "just acknowledge receipt." In accordance with his request, two additional copies were sent (in the event that members of the Board of Trustees desire a copy).

Two copies were also given to a member of this association who is a member of the Board of Trustees, so that he would be in a position to speak on this matter when it was brought before the Board of Trustees at the Miami meeting. In reply to my recent letter, he stated that he has nothing to mention of interest, so I assume that as yet this matter has not been brought to the attention of the Board of Trustees.

Coordination.—This year an attempt has been made to coordinate more closely the efforts of the members of the A.A.O., the chairmen of the Necrology Committees of the component societies, and the committee of the A.A.O. To

this end, a suggested outline of procedure was sent to all the chairmen of the Necrology Committees of the component societies. This was unanimously endorsed by all chairmen and was published in the December issue of the AMERICAN JOURNAL OF ORTHODONTICS. (Appended is an outline of the adopted procedure.)

Your Committee is pleased to report that all the component societies have appointed Necrology Committees, each of which is active and is functioning efficiently in carrying out its respective duties.

Two component societies, the Northeastern Society of Orthodontists and the Central Section of the American Association of Orthodontists, have adopted a policy of preparing an "In Memoriam" resolution on the death of a member, which is presented before the respective society. The Committee recommends that this policy be suggested for the consideration of the other Necrology Committees of the component societies.

Deceased Members.—Since our last meeting of the Association, nineteen members have died. The necrologies which have been prepared for each of these members are retained in the Committee's file.

On April 1, the chairman of each component society received a letter enclosing a list of the deceased members which he was asked to check for omissions and return in the stamped, self-addressed envelope enclosed. As soon as the replies were received, the revised list was forwarded to the secretary of the A.A.O. The chairman of the Necrology Committee of each component society was requested to report by wire any subsequent deaths in the society. Should any occur, these will be included in a supplementary report.

Respectfully submitted.

G. H. HERBERT,
WM. S. SMITH,
G. V. FISK, Chairman.

PROCEDURE WITH REGARD TO NECROLOGIES

Upon the death of a member of the A.A.O., it is desirable that the membership be informed, with a minimum of delay, through the AMERICAN JOURNAL OF ORTHODONTICS.

As the Necrology Committee of the A.A.O. is a rotating committee with the chairman's tenure of office usually of one year's duration, the adoption of a uniform procedure is essential and will be facilitated by a close coordination of the efforts of the members, the chairman of the Necrology Committee of each component society, and the chairman of the Necrology Committee of the A.A.O. in the accomplishment of the above objective.

Members.—As soon as a member of the A.A.O. learns about the death of a member he should report it promptly to the chairman of the Necrology Committee of the component society or to some other person designated to prepare the necrology. (A letter stating available factual data will be of great assistance.)

Component Societies.—All component societies have a standing committee on necrology whose duty, as the necessity arises, is to prepare a suitable necrology, which is read before the society, and to forward a copy to a close relative of the deceased member. Whether prepared as a formal resolution or

as a simple tribute, this necrology is a fitting recognition of the decease of a member. If two additional copies of the necrology are forwarded to the chairman of the Necrology Committee of the A.A.O. and one to the secretary of the A.A.O., these officers will be currently informed.

A.A.O.—When the two copies of the necrology are received by the chairman of the Necrology Committee of the A.A.O., one is forwarded to the editor of the American Journal of Orthodontics and the other is retained for the files of the committee for inclusion in the annual report of the chairman to the Board of Directors of the American Association of Orthodontists. It is desirable that the secretary of the A.A.O. be informed, to enable him to prepare a complete list of deceased members for the program of the annual meeting.

G. H. Herbert,
Wm. S. Smith,
G. V. Fisk, Chairman, Necrology Committee.

REPORT OF THE NOMENCLATURE COMMITTEE OF THE AMERICAN ASSOCIATION OF ORTHODONTISTS, 1955

In keeping with the policy established by previous committees, we have been collaborating with the Bureau of Library and Indexing Service of the American Dental Association, who, for the past several years, have been directing their efforts toward a uniform nomenclature for all dentistry. This seemed logical if orthodontics is to achieve a nomenclature properly integrated with dentistry as a whole.

On Sept. 3 and 4, 1954, the Bureau held a conference in Chicago, which was attended by a member of our committee, Dr. B. F. Dewel of Evanston. Also at this meeting were others vitally interested in this work, who contributed in a constructive way from the standpoint of university teachers. Among these were Dr. George Denton of the American Dental Association and Dr. Kenneth A. Easlick of the University of Michigan. Also taking part in the study was Dr. T. D. Speidel of the Orthodontic Department of the University of Minnesota.

Through Dr. Donald A. Washburn, Director of the Bureau, we furnished reports of previous nomenclature committees to indicate the general trend of the thinking of the orthodontic profession, and we are inclined to believe that these proved helpful.

Two requests for cooperation came from Europe, the first from the State Dental School of Malmo in Sweden, from Dr. Gunnar Tegner of the Department of Orthodontics, and the other from Professor G. Korkhaus, Director of Orthodontics at the University of Bonn. In both communications the necessity for a uniform nomenclature in orthodontics was stressed and our assistance was requested. In replying to these letters, our present policy of working with and through the Bureau of Library and Indexing Service was explained and our cooperation was assured.

In future conferences one of our members, Dr. B. F. Dewel, will endeavor to be present and thereby contribute to the discussion of terms and definitions in which orthodontists have a special interest.

We believe that working with the American Dental Association and participating in these conferences provide orthodontics with a real opportunity to improve its terminology and that we are fortunate in this respect. We believe, therefore, that we may look forward to a constant improvement in general dental terms and that orthodontics will likewise receive marked benefits.

Respectfully submitted,

D. C. MacEwan,
B. F. Dewel,
James D. McCoy, Chairman.

REPORT OF THE PUBLIC HEALTH COMMITTEE, AMERICAN ASSOCIATION OF ORTHODONTISTS

The Committee completed the following work during the past year:

1. Obtained formal acceptance of the changes in the *Cleft Lip and Cleft Palate Guide,* published by the American Public Health Association. The *Guide* received the endorsement of the American Association of Orthodontists on May 19, 1954.

2. Cooperated with the Program Committee of the San Francisco meeting in making possible the presentation of a clinic and exhibit of the Public Health Orthodontic Program of the State of New York, in order to acquaint the membership with this program and to answer numerous questions relating thereto.

3. Arranged a conference of representatives of the sectional societies of our Association to discuss plans for a national survey of existing public health orthodontic programs, hospital, and private orthodontic clinics. This is in compliance with the recommendation of the Public Health Committee adopted by the Association on May 19, 1954.

4. The final draft of the *Guide on Dento-Facial Handicaps,* to be published by the American Public Health Association, including the changes submitted by the Public Health Committee of our Association, is now ready for adoption by the Board of Directors of the American Association of Orthodontists.

5. The "Principles for Determining Acceptability for Participation in Public Health and Prepayment Orthodontic Plans by Members of the American Association of Orthodontists" were published in the American Journal of Orthodontics in September, 1954, page 723. Reprints have been obtained and will be distributed to the membership after the adoption by the Association of the *Guide on Dento-Facial Handicaps.* The foregoing is in compliance with the resolution adopted by our Association at Chicago on May 19, 1954.

The Committee recommends the following:

1. The proposed national survey on public health orthodontic care should include the orthodontic phase of cleft palate treatment.

2. The plan of the survey should be submitted to the Board of Directors of the Association for approval before it is put into effect.
3. The Committee should be empowered to seek the cooperation of Public Health Associations, the American Dental Association, the American Medical Association, and other public health agencies in the preparation of the public health orthodontic survey.
4. The Public Health Committee should be allowed a budget of $500.00, in view of the expanding activities of this Committee.

Respectfully submitted,

OREN A. OLIVER
L. BODINE HIGLEY
STEPHEN C. HOPKINS
HERBERT K. COOPER
J. A. SALZMANN, Chairman.

REPORT OF THE RESEARCH COMMITTEE, AMERICAN ASSOCIATION OF ORTHODONTISTS

THE work of the Research Committee consisted of conducting the 1955 Prize Essay Contest and in arranging the Research Section.

Seven entries were submitted for the Prize Essay Contest, of which the Committee selected the following:

PRIZE ESSAY

Viken Sassouni, Instructor in Orthodontics and Cephalometrics, Philadelphia Center for Research in Child Growth, 1701½ Fitzwater St., Philadelphia, Pennsylvania. *Title:* A Roentgenographic Cephalometric Functional Analysis of Cephalo-Facio-Dental Relationships Based on the Study of Concepts of Architectural Structure.

FIRST HONORABLE MENTION

Milton L. Braun, Chicago, Illinois, and William G. Schmidt, Evanston, Illinois. *Title:* A Cephalometric Appraisal of the Curve of Spee in Class II, Division I Occlusions for Males and Females.

SECOND HONORABLE MENTION

Robert W. Baker, Ithaca, New York. *Title:* Dental Changes Accompanying Treatment of Class II Malocclusions by Extraoral Means.

Reports to be read at the Research Session and those to be presented by title only are published in the supplementary program.

The Committee recommends the following:

1. Announcements of the Prize Essay Contest and the Research Session should be made in as many scientific journals as possible in the

United States and elsewhere, and should not be confined to orthodontic and dental journals alone. The purpose of this recommendation is to attract wider interest not only among dentists and specialists in orthodontics, but also among workers in other fields closely related to orthodontics.

2. The final date for receiving entries to the Prize Essay Contest should be set early enough to include the name of the prize essay contest winner in the official program of the American Association of Orthodontists.
3. The budgetary allowance should remain as in previous years.

The Chairman of the Committee on Research wishes to thank the members of the Committee for their wholehearted and prompt cooperation. Special mention is made, with thanks, to Alton W. Moore, for the efficient manner in which he handled the details of the Prize Essay Contest, and to Thomas D. Speidel, for his work in arranging the research session.

Respectfully submitted,

J. William Adams
Herbert I. Margolis
Alton W. Moore
Thomas D. Speidel
J. A. Salzmann, Chairman.

We regret to announce that, just previous to going to press, we received word of the death of Dr. William Murray of Chicago, a past-president of the American Association of Orthodontists. An obituary will appear in a later issue of the Journal.

Department of Orthodontic Abstracts and Reviews

Edited by

DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City

Biometrics of Crowding and Spacing of the Teeth in the Mandible: By Coenraad F. A. Moorrees and Robert B. Reed. *Am. J. Phys. Anthropol.* **12**: 77-88, March, 1954.

The alignment of the teeth in the dental arch is partially dependent on the ratio between the size of the teeth and the size of the dental arch. A perfect alignment of the teeth is possible only when an optimum relationship between these two factors exists. A disproportion between the size of the arch and that of the teeth which it contains results in either crowding or spacing of the teeth.

In the present study a biometric analysis was made of spacing or crowding of the teeth in the mandible. The study was confined to the mandibular dentition because it was reasoned that in the mandible the teeth, especially the incisors, are generally positioned directly over the basal arch, whereas in the maxilla this is not as often the case. The long axes of the maxillary incisors may have a considerable inclination to the occlusal plane and, therefore, the maxillary dental arch may have a larger circumference than the bony basal arch. Since the size of the dental arch (the arch formed by the crowns of the teeth) is likely to correspond more closely to the basal arch in the mandible than in the maxilla, it seemed to the writers that, when only casts are used, the relationship just discussed can be evaluated more effectively by studying the mandibular dentition.

The material available for analysis consisted of seventy-two plaster casts of the mandibular dentition of 18- to 20-year-old American women of European stock, with a full complement of permanent teeth (M_2 to M_2). None of these subjects had received orthodontic treatment. The plaster casts were obtained from hydrocolloid impressions, since this method provides an accurate anatomic representation of the dentition.

On the plaster casts measurements were made of mesiodistal crown diameters of the teeth, the amount of spacing or crowding, and the size of the dental arch.

Mesiodistal crown diameter was obtained by measuring the greatest distance between the approximal surfaces of a tooth. The crown dimensions of individual teeth have been added to obtain a metric value for the total tooth material exclusive of the second and third molars.

Spacing was measured by placing wires of different, but known, gauges in an interdental space until a wire was found which corresponded in thickness, with 0.1 mm., to the width of the space at the level where approximal contact usually occurs.

Crowding was measured as the lack of space for a tooth in the dental arch. This metric expression for the degree of crowding was derived by subtracting the amount of space available for a crowded tooth in the dental arch from the mesiodistal crown diameter of the former.

The size of a dental arch was expressed in terms of the length of the curve extending from the distal surface of the left mandibular first molar to the distal surface of its antimere, measured along the midline of the row of teeth between these points. Two different methods for determining this linear dimension were utilized, namely: (1) sum of mesiodistal crown diameters (M_1 to M_1) minus crowding and, in the case of spacing of the teeth, (2) sum of mesiodistal crown diameters (M_1 to M_1) plus spacing. According to this method, the size of the dental arch was obtained indirectly by utilizing the measurements for the individual teeth and those for spacing or crowding.

Another expression for the size of the dental arch was obtained by measuring the distances between infradentale and the distal surfaces of the mandibular first molars. These two dimensions, which are functions of the length and breadth of each half of the dental arch, when added together only approximate the true size of the dental arch, as they do not take its curved contour into consideration. This measure for arch size, however, is totally independent from that obtained indirectly by considering the diameters of the tooth crowns and the measures for crowding and spacing.

The results obtained by these two methods were compared by calculating the coefficient of correlation. This coefficient was quite high, that is, $+0.97 \pm 0.007$ ($n = 72$). It is of sufficient magnitude to permit the use of the first method of measurement, which is considered to give a more accurate approximation of the actual length of the curved line that characterizes the dental arch of man.

The aim of this study, as stated previously, is to examine the sources of variations in the alignment of the teeth in causing spacing and crowding of the mandibular teeth of the persons furnishing the data.

The findings of the present study show that crowding may occur in persons with less than average tooth size and also in persons with greater than average arch size.

It is difficult to evaluate the various factors leading to crowding or spacing of the teeth by merely correlating the size of the tooth crowns or the size of the dental arch with the amount of crowding or spacing, since both conditions are the joint product of the size of the teeth and the size of the dental arch.

The method used in the present study leads to a clearer evaluation of the role which tooth size and arch size play in the causation of spacing and crowding. In fact, it has been shown that a discrepancy between the variances of tooth size and arch size plays practically no part and that, actually a lack of association between tooth size and arch size leads to crowding and spacing in the mandibular dentitions of the 72 young women studied. This conclusion should be accepted within the limitations imposed by the method of analysis and the source of the data.

Case Report of Radiation Injury of Teeth and Jaws: By Takeo Murai, ***Bull. Tokyo Med. Dent. Univ.*** **3**: 84, 1955.

A 12-year-old girl was referred to the dental department of the Central Health Center of the City of Sendai because of masticatory disturbances and underdeveloped small jaws. She was well developed, mentally and physically, for her age, but was somewhat poorly nourished.

She had a homogeneous red-colored skin over the entire mandible at birth, which was diagnosed as hemangioma simplex. Subsequently, she was

treated by x-ray from the forty-seventieth day after birth. The technique applied was a short, distant irradiation after Chaoul. For the first six months the radiation was continued once a week; each sitting was for three to five minutes and it was arranged that only the above-mentioned skin lesion was irradiated. For the following three years radiation was continued at one-month intervals, and then radiation therapy was discontinued. During her infant and childhood stages there were no particular findings in the number and form of deciduous teeth and dental arches or in the masticatory function.

On examination, it was noted that the skin color in the mandibular region was dark brownish red; this skin coloring was diagnosed as telangiectatic capillaries, and it was found that some depigmented small flecks had appeared on the atrophic skin of that area. There were no peculiar findings on the mucous membrane of the lips and oral cavity, but there was a marked underdevelopment of the jaws and an abnormal dentition. Dentition was $\dfrac{\mathrm{65\ 3\ I} \mid \mathrm{123IV\ 6}}{\mathrm{6\ \ cb} \mid \mathrm{\ \ c\ 6}}$. All teeth except IV belong to the permanent dentition, but their crowns were all small; their roots especially were short and thin, as shown by the radiograph.

The mandibular region with the tooth germs was exposed to a great dose of x-ray which would be assumed from the appearance of the skin which was injured by radiation. The duration of the radiation therapy was from the forty-seventh day after birth to about the third year of age. During this period many tooth germs, where the hard tissue formation had or had not commenced, might have been irradiated.

The results of experiments gave the conclusion that the younger the animal and the earlier the stage of development, the more severe is the damage to the tooth germs. When the total amount of the dose of fractionating radiations reached a certain level which will cause marked anomalies of teeth, the tooth germs of $\dfrac{\ \mid\ }{6 \mid 6}$ were affected slightly and the latter severely. The same explanation could be given in the case of deciduous and permanent teeth. The teeth of the upper jaw are slightly affected as compared with those of the lower, this being due to the differences in the distance from the irradiated skin field. The underdeveloped small jaw may be due to the severe radiation. This case is of particular interest because the opportunities to demonstrate the effects of radiation therapy on the developing tooth structures are rare.

The Use of Partial Vitamin Supplements in the Treatment of Growth Failure in Children. By Jean Crump, M.D., and Robert Tully, M.D., Philadelphia, Pa. *J. Pediat.* **46**: 671-681, June, 1955.

In the majority of the children studied, a report of poor appetite and/or a clinical impression of retarded growth and development was prominent in the clinical picture. All were children between the ages of 3 and 12 years, who had been under observation for at least a year before treatment, although a few of the height and weight measurements were taken for a shorter prior period.

Growth failure in most instances was secondary to chronic disease. Thirty-two children had allergic disorders, including hay fever, vasomotor rhinitis, asthma, eczema, or gastrointestinal allergy. A few had an associated endocrine deficiency. Other diagnoses included congenital heart disease and feeding and behavioral problems. Clinically, the condition of each child was considered to be in a stabilized state and the treatment in the pre-experiment period was the same as that during the supplementation with B_{12} and B_1.

The heights and weights of the children were recorded at frequent intervals. Where prior observation was sufficiently complete to establish a child as his own control, his progress was plotted on Wetzel grids. Adequate data were available for thirty-two children. Each child was kept on the supplement for at least a year. Observations on many of the children were extended beyond the second year. Seasonal spurts in growth were minimized by staggering the admissions to the study and by the length of observation following initiation of treatment.

Parental reports of increases in appetite and improvement in activity and disposition were almost uniform. There was a definite impression that the use of this daily supplement of 25 μg of vitamin B_{12} and 10 mg. of vitamin B_1 was exerting a beneficial effect in the management of these children.

Patient acceptance of the vitamin preparation was good and, as a result, the reliability of administration by the mother was assured. On physical examination, improvement in many children was noted during the period of the study, and in many this seemed unexpected in view of their previous course.

It is clear from the results obtained in this study that chronically ill children do not differ substantially from those with no evidence of disease in their pattern of response to vitamin B_{12} therapy. In some cases the arrest of growth failure occurred during the first year, with recovery of substance and physique evident the second year. In Group I (those children showing a definite pattern of malnutrition), nine out of twelve showed some degree of response during the first year of supplementation, while eleven out of thirteen were improving or holding their gains in the second year. Out of the whole group of thirty-two, there was definite reversal of trend with $B_{12} - B_1$ in twelve children; this figure increased to sixteen probable positives by the second year. Thus, with patients classified according to the Wetzel criteria, a significant improvement in malnourished children took place when they were given supplements of 25 μg of B_{12} and 10 mg. of B_1 orally each day.

All the children studied gave a clinical impression of improved nutritional status with reports of increased appetite and concomitant weight gains. Analysis of the grid data, however, indicates that an actual increase in growth rate occurred only when growth failure was genuinely present prior to treatment. The greater gains achieved by those in Group I substantiate the observation by other investigators that the degree of response parallels the need for improvement. It has never been contended that B_{12} therapy will cause a normal child to become obese. Rather, the preferential action of the vitamin seems to be directed toward the simple growth failures which are responsive to an increased food intake. Vitamins B_1 and B_{12} have other physiologic roles in addition to their mutual appetite-stimulating effect. The maintenance of a normal carbohydrate metabolism and a properly functioning gastrointestinal tract by thiamine and the regulation of protein and lipid synthesis by vitamin B_{12} are important adjuvants to recovery from depressed growth.

News and Notes

1956 Prize Essay Contest, American Association of Orthodontists

Eligibility.—Any member of the American Association of Orthodontists and any person affiliated with a recognized institution in the field of dentistry or associated with it as a teacher, researcher, undergraduate, or graduate student shall be eligible to enter the competition.

Character of Essay.—Each essay submitted must represent an original investigation and contain some new significant material of value to the art and science of orthodontics.

Prize.—A cash prize of $500.00 is offered for the essay judged to be the winner. The committee, however, reserves the right to omit the award if, in its judgment, none of the entries is considered to be worthy. Honorable mention will be awarded to those authors taking second and third places. The first three papers will become the property of the American Association of Orthodontists and will be published. All other essays will be returned.

Specifications.—All essays must be in English, typewritten on 8½ by 11 inch white paper, double spaced with at least 1 inch margins. Each sheet must be numbered and bound or assembled with paper fasteners in a "brief cover" for easy handling. Three complete copies of each essay, including all illustrations, tables, and bibliography, must be submitted. The name and address of the author must not appear in the essay. For purpose of identification, the author's name, together with a brief biographical sketch which sets forth his or her dental and/or orthodontic training, present activity, and status (practitioner, teacher, student, research worker, etc.) should be typed on a separate sheet of paper and enclosed in a sealed envelope. The envelope should carry the title of the essay.

Presentation.—The author of the winning essay will be invited to present it at the meeting of the American Association of Orthodontists to be held at the Statler Hotel, Boston, Massachusetts, the week of April 29, 1956.

Judges.—The entries will be judged by the Research Committee of the American Association of Orthodontists.

Final Submission Date.—No essay will be considered for this competition unless received in triplicate on or before Jan. 10, 1956, by Dr. Thomas D. Speidel, University of Minnesota, School of Dentistry, Minneapolis 14, Minnesota.

H. I. Margolis, Chairman, Research Committee
American Association of Orthodontists
311 Commonwealth Ave.
Boston 15, Massachusetts

American Association of Orthodontists, 1956 Research Section Meeting

Continuing the policy of recent years, the program will consist of a series of ten-minute research reports which may be presented orally or read by title only. All persons engaged in research are urged to participate in this program, which will be held on April 29 and 30 and May 1 and 2, 1956, in the Statler Hotel, Boston, Massachusetts.

Each participant is asked to prepare a 250-word abstract for publication in the AMERICAN JOURNAL OF ORTHODONTICS. Abstract for publication and the ten-minute oral presentation at the meeting should be carefully prepared to present an adequate description of the import of your investigation.

Forms for use in submitting the title and 250-word abstract of your research will be sent to each dental school orthodontic department and to any individual requesting one. Please send your title and abstract as early as possible, but not later than Jan. 10, 1956, to Dr. J. William Adams, 707 Bankers Trust Bldg., Indianapolis 4, Indiana.

H. I. Margolis, Chairman, Research Committee
American Association of Orthodontists
311 Commonwealth Ave.
Boston 15, Massachusetts

American Board of Orthodontics

The next meeting of the American Board of Orthodontics will be held at the Statler Hotel in Boston, Massachusetts, April 24 through April 28, 1956. Orthodontists who desire to be certified by the Board may obtain application blanks from the secretary, Dr. Wendell L. Wylie, University of California School of Dentistry, The Medical Center, San Francisco 22, California.

Applications for acceptance at the Boston meeting, leading to stipulation of examination requirements for the following year, must be filed before March 1, 1956. To be eligible, an applicant must have been an active member of the American Association of Orthodontists for at least three years.

Honorary Degree Awarded to Dr. F. S. McKay

Dr. Frederick S. McKay, one of the country's pioneer orthodontists, formerly located in St. Louis, Missouri, and Colorado Springs, Colorado, and now an authority on the relationship between the fluoride content of drinking water and tooth decay, was awarded an honorary Doctor of Science degree at the University of Colorado's summer commencement exercises on Saturday, Aug. 27, 1955.

Dr. McKay has been given international recognition for his research supporting the fact that the addition of the correct amount of fluoride to a community water supply that is deficient or lacking in natural fluorine content will lessen tooth decay.

Dr. McKay first became interested in the relation of fluorine and dental health as early as 1908. Since that time he has devoted himself to fluorine research and water fluoridation studies in cooperation with other fellow researchers and dental health planners.

American Public Health Association

Reports on a wide variety of developments related to dental public health will be presented before the 83rd annual meeting of the American Public Health Association and meetings of forty related organizations in the Kansas City, Missouri, Municipal Auditorium, Nov. 14-18, 1955.

The meetings will bring together more than 5,000 public health specialists from Governmental agencies, voluntary organizations and institutions, and private practice in all parts of the United States and from many other countries.

Dr. Reginald M. Atwater, executive secretary of the Association, and Dr. Carl L. Sebelius, secretary of the Dental Health Section of the Association, have announced a tentative program which includes the following papers of interest to the dental health field:

ORTHODONTIC CARE. David B. Ast, D.D.S., Director, Bureau of Dentistry, New York State Department of Public Health.

SHORT- AND LONG-TERM OBJECTIVES IN DENTAL PROGRAM PLANNING (a panel discussion). Presiding will be H. Shirley Dwyer, D.D.S., Chairman of the Dental Health Section of the Association and Director of the Division of Dental Hygiene, Arkansas State Board of Health. Participants will be Thomas L. Hagen, D.D.S., Chief, Division of Dental Public Health, U. S. Public Health Service; Arthur Bushel, D.D.S., Director of Dentistry, City of New York Department of Health; Lester Gerlach, D.D.S., former Director of Dental Health Service, Milwaukee Department of Health; William A. Jordan, D.D.S., Director, Division of Dental Health, Minnesota State Health Department; John W. Stone, D.D.S., Director of Dental Health, Mississippi Department of Health.

Notes of Interest

Arthur I. Bell, D.D.S., announces that he has moved his office from 406 Medical Arts Bldg., Baltimore, Maryland, to 813 Frederick Ave., Catonsville, Maryland, practice limited to orthodontics.

Gerard A. Devlin, D.D.S., announces that he has discontinued his practice at Newark, New Jersey, and now limits his time to his practice at 123 Prospect St., Westfield, New Jersey.

G. Vernon Fisk, D.D.S., announces the Association of Ross O. Fisk, D.D.S., M.S., at 818 Medical Arts Bldg., Toronto, Ontario, practice limited to orthodontics.

Maurice J. Kimelman, D.D.S., M.S.D., announces the opening of his offices for the exclusive practice of orthodontics at 8719 Van Nuys Blvd., Panorama City, California.

John E. Sage, D.M.D., announces the removal of his office to the Flushing Medical Bldg., at 42-27 Union St., Flushing, L. I., New York, practice limited to orthodontics.

Dr. William R. Schmidt, orthodontist, announces the opening of his office in the Coppin Bldg., 7th and Madison, Covington, Kentucky.

Richard A. Schwalb, D.D.S., announces the opening of his office for the limited practice of orthodontics at 17 West Blackwell St., Dover, New Jersey.

Frederick W. Spaulding, D.M.D., announces the opening of his office on March 1, 1955, at 433 Main St., Manchester, Connecticut, practice limited to orthodontics.

Claude R. Wood, D.D.S., announces the association of Thomas G. Townes, D.D.S., Lake Avenue Dental Bldg., 1701 Lake Ave., Knoxville, Tennessee.

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